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DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

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One of the largest industrial power plants in New England

Steam for Chile's New Steel Plant ▶

Report of MIDWEST POWER CONFERENCE ▶

Two Years Performance at Chesterfield Station ▶

Recent C-E Steam Generating Units for Utilities

CHESTERFIELD POWER STATION

VIRGINIA ELECTRIC AND POWER COMPANY

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It is designed to produce, at maximum continuous output, 650,000 lb of steam per hr at 875 psi and a total temperature of 900 F.

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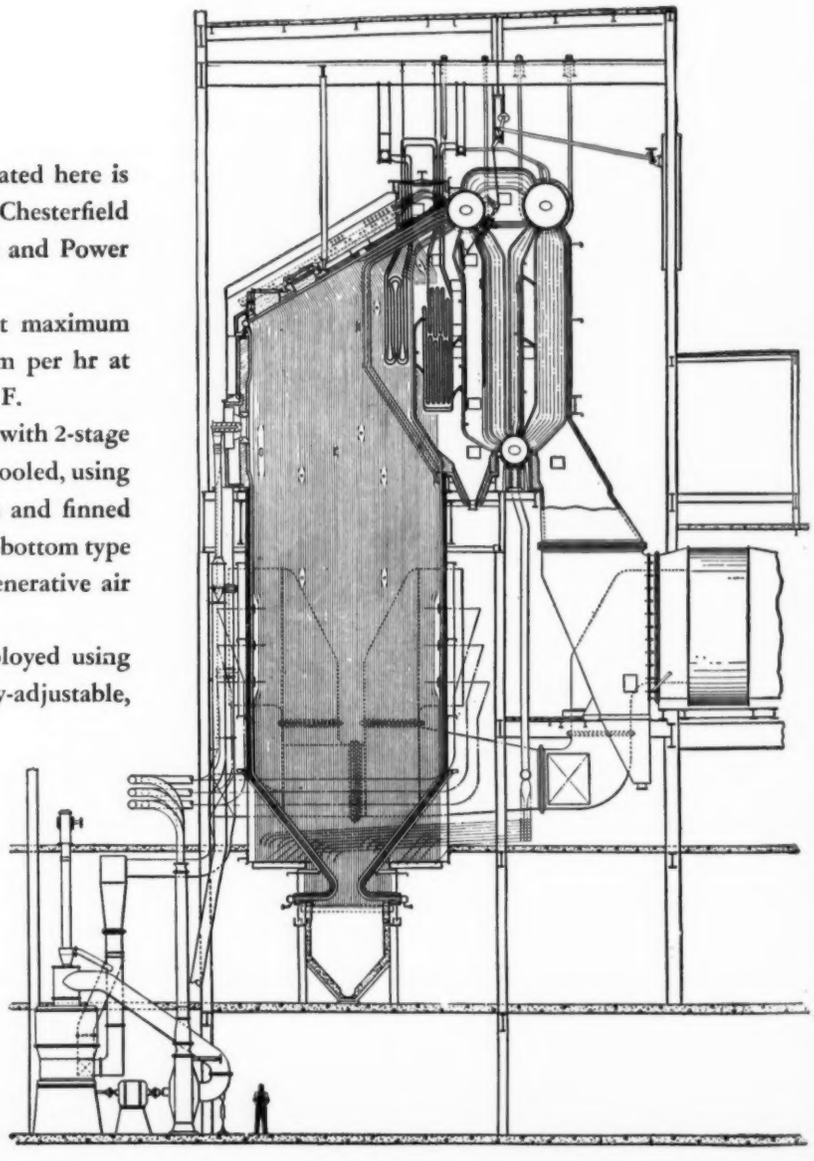
B-200



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COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

VOLUME NINETEEN NUMBER TEN

CONTENTS

FOR APRIL 1948

FEATURE ARTICLES

Steam for Chile's New Steel Plant ..... *by F. C. Senior* 32

Midwest Power Conference

Future Power Needs; Foreign Power Situation; An Appraisal of the Fuel Situation; The Trek of Industry Westward; Application of Heat Balance to Industrial Plants; Furnace Design; Boiler Water Treatment; Experiences with Multiple Fuel Firing; Iron in Feedwater; Causes and Prevention of Condensate Return-Line Corrosion; High Alkalinity and Organic Material for Sludge Removal; Gas Turbine Test; Electric Power in Japan; Power Plant Operator Training 35

Two Years Performance at Chesterfield Power Station ..... *by R. S. Reed* 43

Court Decisions Affecting Power Plants ..... *by Leo T. Parker* 47

EDITORIALS

Industry Again Penalized 31

The Engineer in Civic Affairs 31

DEPARTMENTS

New Equipment 54

Business Notes 55

Advertisers in This Issue 56

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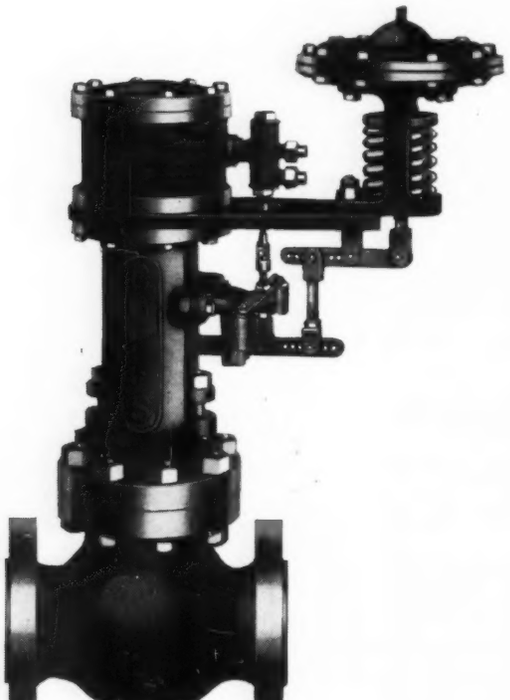

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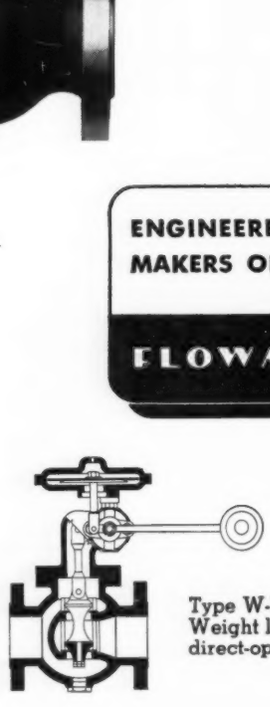
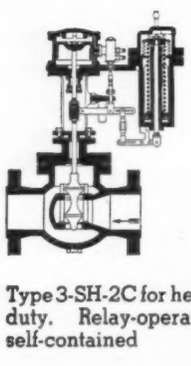


Type W-DBI. Weight loaded, direct-operated



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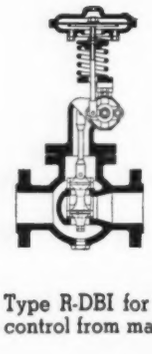

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EDITORIAL

Industry Again Penalized

The coal strike could hardly have been staged at a worse time from the standpoint of gravely affecting industrial production. As this is written, the miners have been "unwilling to work" for more than a month; but through the efforts of Speaker Martin and Senator Bridges in bringing about a compromise on the pension demands, are slowly returning to the mines. However, the loss in production is irreparable. Exports of badly needed coal to Europe were stopped; railroad schedules had to be drastically curtailed; and production in many lines was seriously affected, with consequent loss of wages to thousands of workers. But the most devastating of all has been the effect on steel output at a time when the demand for durable goods is at an all-time high and the steel industry has been experiencing great difficulty in meeting deliveries. In fact, the plate situation has long been tight and is becoming still tighter—a condition that is playing into the hands of black market speculators.

Superimposed on the present domestic and commercial demand for steel are the prospects of large demands to meet a national defense program, a government-sponsored shipbuilding program, and the requirements of the Marshall Plan which is now getting set to function. Reference to the power requirements set up for ERP, as given in the table on page 35 in the Midwest Power Conference Report, will indicate the extent to which demands will be made upon American steel production for this purpose alone.

Many are now of the opinion that in view of the unprecedented demands and the loss in steel output as a result of the coal strike, it may become necessary to institute some form of control of this commodity; notwithstanding the undesirability of such a measure, from certain angles.

The whole productive and economic structure of the nation is so dependent upon a sustained fuel supply that such an interruption is indefensible, regardless of the points at issue. A repetition of the situation every two years at the expiration of a coal contract, or in the interim to suit the whims of John Lewis, is becoming intolerable. Some way must be found to settle labor disputes in the coal industry without penalizing all industry through stoppage of coal supply.

The Engineer in Civic Affairs

For many years there has been much talk and agitation within engineering circles for engineers to take a more active part in civic affairs, both national and local, to an extent comparable with that of the legal and medical professions. It is pointed out that engineers are held high in public esteem, yet their advice is seldom sought on public affairs, despite the important rôle of engineering in our social and economic advancement as well as in our national defense.

It is a fact that considerable progress has been made by engineers collectively, through their professional societies, in achieving such recognition in certain localities and to a lesser extent nationally—probably to a greater extent than is realized by the average member—but there is no denial of the fact that individually engineers have not attained the influence in public affairs, neither local nor national, that has been achieved by lawyers.

Many explanations have been offered for this situation but fewer practical suggestions have been made for overcoming it. It is therefore pertinent to note the advice given by S. M. Dean, of The Detroit Edison Company, in a talk before the Midwest Power Conference, who said in substance:

"The first requirement is that we rid ourselves of the commonly held opinion that governmental agencies and politicians are per se a no good lot. The rôle of the legislator or public official is not an easy one. . . . They are under constant and confusing pressures from several departments of government affected, the press, and various pressure groups, and are glad to turn to someone of their acquaintance who has experience in the situation in question, and in whose integrity and judgment they have confidence. . . . That is where the public-spirited engineering group comes in. . . . If the engineers of such a group can make the acquaintance of the public's representatives and executives and by being helpful can gain their confidence, they will be on the road to exercising a real influence in public affairs."

This is sound advice based on the experiences of one of a group of engineers that has taken a notably successful part in local affairs. It is worth applying more generally, by both engineering bodies and individual engineers, wherever opportunity is offered.

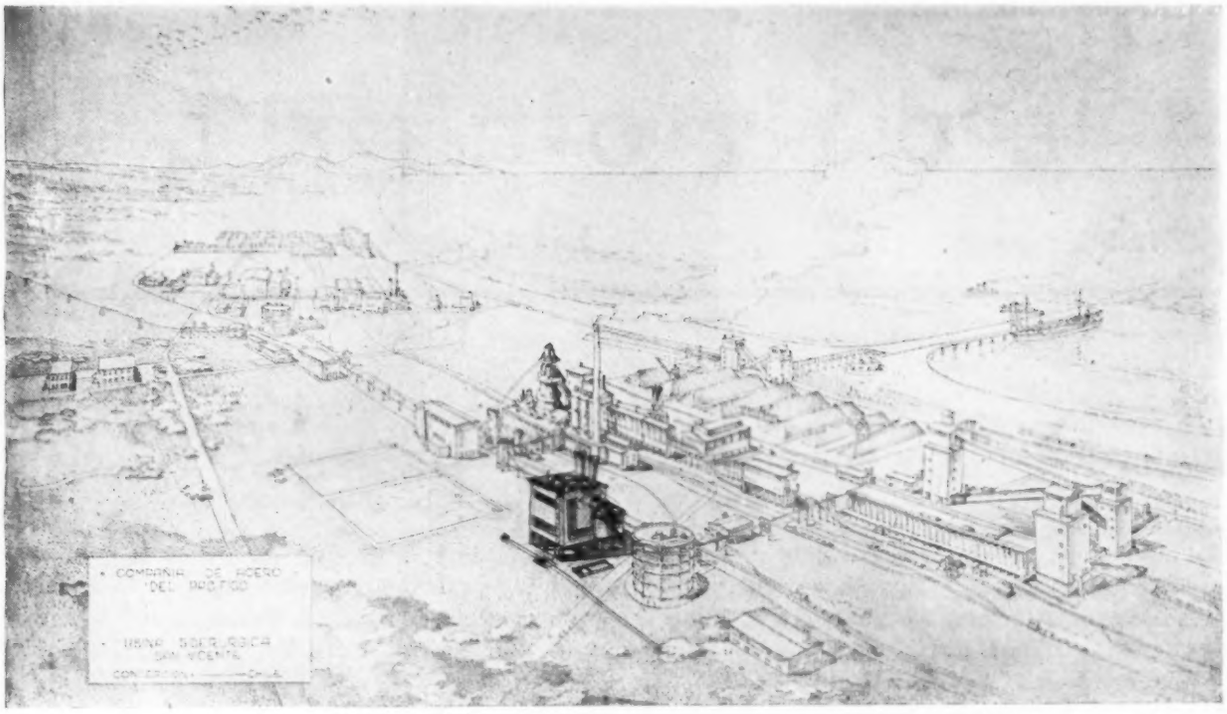

Fig. 1.—Artist's sketch of steel plant with power plant in center foreground

Steam for Chile's New Steel Plant

By F. C. SENIOR

Engineering Manager, Chile Steel Project, Koppers Company

This steel plant now under construction will be the second largest in South America. Its boiler plant will initially contain two 70,000-lb. per hr steam generating units designed for burning coke breeze and blast-furnace gas or coke-oven gas. A waste-heat boiler will generate steam by waste heat from the open-hearth furnace. Normally, electricity will be supplied over a 90-mile transmission line from a hydro plant, but a 2500-kw condensing turbine-generator at the plant will provide standby power.

COMPAÑIA de Acero del Pacifico is now constructing a complete integrated steel plant in Chile, South America. The Koppers Company of Pittsburgh is collaborating in its construction and will also participate in its future operation through a co-management contract with Acero. The plant is located on the shores of the Pacific on San Vicente Bay near Concepcion, about 300 miles south of Santiago, and will be the most southerly, integrated steel works in the world. It represents South America's second important integrated steel-producing unit. The initial installed capacity will be approximately 250,000 tons of ingots per year.

Chilean raw materials will be employed in operation almost exclusively, the ore and limestone being transported by sea to the company's pier, and the coal hauled by rail from the Lota and Schwager mines, approximately 30 miles south of the plant. Electrical energy will be of hydroelectric origin from Endesa's new station at Abanico, approximately 90 miles distant, and brought in at 154,000 volts to the Company's main sub-station. The Chilean coals possess adequate coking properties, and it is expected that selective mining will insure coke of acceptable quality for good blast furnace operation.

Briefly, the installation will consist of a pier and boat-unloading tower located in the bay, a raw material bedding and conveying system to insure uniformity of raw materials; a 57-oven complete Koppers by-product coke plant; a 20-ft diameter hearth; a modern blast furnace to be blown by motor-operated blowers; a steel-producing department, including bessemer converter and open-hearth furnaces; soaking pits and a 32-in. blooming mill; the finishing mills, including a 26–18-in. billet and sheet bar mill; an 18-14-12-10-in. combination rod and merchant mill; sheet, plate and tin-plate mills; and a boiler house and standby turbine-generator station of 2500 kw initial capacity.

The plant fuel balance is predicated on underfiring the

coke ovens with clean blast-furnace gas; normal use of blast-furnace gas at the furnace; motor-operated blast-furnace and bessemer blowers; blast-furnace gas base fuel on the soaking pits and reheating furnaces with mixed 450-Btu gas enrichment; coke-oven gas and fuel oil on the open-hearth with a waste-heat boiler; and supply of 450-Btu mixed gas to the Concepcion area through the plant's distribution system.

Base fuel for the steam generating unit will be coke breeze (minus $^1/_2$-in. mesh) of approximately 10,000 Btu per lb heating value, supplemented by coke-oven gas to the limit of its availability, and "dumped" blast-furnace gas to meet load requirements. It is contemplated that it will not be necessary to use more than 0.5 per cent of the total fuels when supplying the Concepcion area with mixed coke-oven gas, and the only purchased fuel will be oil for proper control in the open-hearth furnance.

Fuel Balance

The plant is located in a very mild temperature zone with consequent minimum heating requirements, small need for atomization steam for fuel oil burning, and no large steam-consuming units in normal operation. Conditions now existent in Chile are such that it appears uneconomical to operate the blast-furnace and the bessemer blowers with electrically-driven units. It is to be noted, therefore, that installed steam generating capacity in this plant is somewhat smaller than the usual steel plant practice in the United States.

A standby turbine-generator of 2500-kw capacity is also being installed. This is a straight condensing unit with 250-psi and 506-F steam at the throttle, to maintain certain critical operations in the plant in the event of power failure.

It will be noted from the cross-section that the power station contains the fuel dispatcher's office for the entire steel plant. This office is in reality the "heart" of the plant, and it is from this point that operations will be controlled during any crisis. The dispatcher will supervise and direct the use of generated power during times of

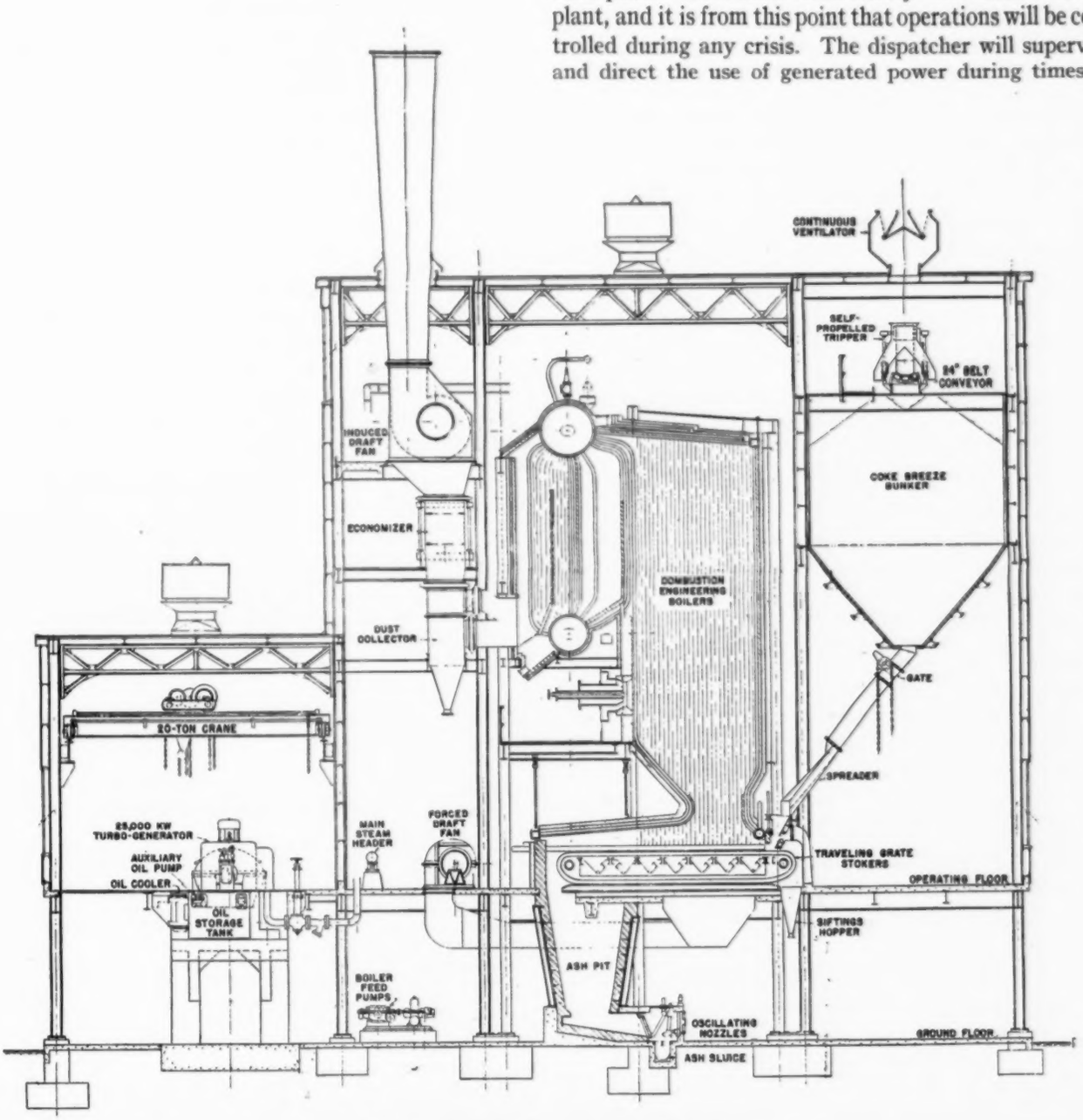

Fig. 2.—Section through power plant

purchased power failure, as well as control distribution of all gaseous fuels, steam, water and other utilities from this point.

Steam Generating Units

Steam at 250 psi, 506 F will be provided by two Combustion Engineering steam generators, each rated at 70,000 lb per hr when burning 100 per cent mixed coke-oven gas and 50,000 lb per hr on straight blast-furnace gas or coke breeze. It will be noted from the station cross-section that they are of the two-drum bent-tube type with water-cooled furnace and a long rear arch over the stoker. Each boiler has a 14-ft wide by 19-ft long Coxe traveling grate stoker designed to burn coke breeze with cold air, an Elesco interbank superheater and a continuous thin tube economizer.

The gaseous fuel will be burned in two type R combination blast-furnace and coke-oven short-flame burners with mixed gas pilot. They are arranged to fire from the rear toward the front wall. It is imperative in multiple-fired boilers, particularly when coke breeze is burned in combination with blast-furnace gas, that maximum possible protection be given the economizer and the induced-draft fan. Therefore each unit will incorporate a Western Precipitation tubular type collector having a guaranteed efficiency of not less than 85 per cent (based on breeze fly ash no finer than 80 per cent plus 10 microns). Bypass dampers are provided around the dust collector for starting up and when on 100 per cent gaseous firing.

Each steam generator is served by a turbine-driven forced-draft fan and a turbine-driven induced-draft fan with Thermix type stub stacks. Automatic combustion control has been provided.

Three fuels will be burned in the following order of preference: blast-furnace gas, coke breeze and coke-oven gas. The fuel and combustion controls will be required to supply these fuels selectively to the boilers in this order, retaining at the same time, sufficient operation of the coke breeze stokers to maintain ignition and totalize the air requirements for each fuel on a correct basis, and maintaining a predetermined excess air for each fuel. Superimposed upon the controls, there will be a blast-furnace gas pressure impulse, significant as to the availability of blast-furnace gas. In case this gas is unavailable and coke breeze, as fired on the stoker, is insufficient to meet steaming requirements, coke-oven gas will be supplied by the controls to meet requirements.

Boiler feedwater will come from the plant system whose source will be the Rio Bio Bio, approximately 6 miles distant. It will be subjected to hot-process soda-lime treatment and delivered to the economizer by either of two turbine-driven and one motor-driven centrifugal boiler feed pump each of 200 gpm capacity. The former will be for normal operation and the latter for starting up or to adjust the heat balance if required.

Breeze and Ash-Handling System

Coke breeze will be brought in from track hoppers by an automatic skip system and delivered to 275-ton storage bins by a traveling-tripper belt conveyor.

Decision to locate the gas producer (required to start the coke-ovens and to insure continuity of gas production) adjacent to the boiler house was made in order to consolidate the breeze and ash-handling equipment. A belt conveyor delivers coke to the producer bin from the boiler house when required.

Ashes will drop to the ash pit and will be removed intermittently by a movable hydraulic jet. The ash-laden water will then pass through suitable sluices equipped with hydraulic jets to the grab bucket ash pit sump to be located just north of the boiler house. The ash-carrying water will be recirculated. Ashes will then be removed from the pit to either railroad cars or trucks by means of yard cranes.

Standby Power

The standby turbine-generator will have a capacity of 2500 kw at 0.8 pf, 3-phase, 50 cycles, 13,800 volts. It will be a 3000-rpm straight condensing machine operating on 250 psi and 506 F steam at the throttle. Its surface condenser will have 4680 sq ft of surface and develop 2 in. Hg absolute pressure.

One of the features of this installation is the necessity of insuring continuity of power in case of failure of the hydro power from Endesa. It was decided that in order to enable the steel plant to empty furnaces, pour ladles and in general prepare for limited shutdown, as well as insure continuity of gas flow, this turbine would have to be on the line in 10 min or less. We therefore contemplate providing it with a simple turning gear in order to maintain it in "ready" condition at all times.

Another feature is that, in case of power failure, all emergency air will be supplied by turbine-driven compressors. There is also a steam-driven fire pump.

Waste heat from the open-hearth furnace will be taken up by a C.E. waste-heat boiler of the horizontal fire-tube type which will generate approximately 8000 lb of 250-psi, 506-F steam when passing 1200-F waste gas.

The consulting engineer for this station is The Kuljian Corporation, Philadelphia, Pa.

PRINCIPAL MECHANICAL EQUIPMENT

Steam-Generating Units

Two 70,000-lb per hr, two-drum bent-tube *Combustion Engineering* boilers, 250 psi working 506 F steam temperature; triple-fired with blast-furnace, coke-oven gas and coke breeze or a Coxe traveling grate stoker. Boiler heating surface 7180 sq ft, and water walls 1525 sq ft. *Elesco* superheater. Furnace volume 5500 cu ft. *Elesco* economizer 1490 sq ft. Calculated maximum unit efficiency on 100 per cent coke-oven, 78.8 per cent; and 81.5 per cent on 100 per cent coke breeze firing.

Turbine Generator

One 3125-kva (0.8 pf), 3000-rpm *International General Electric* unit operating at 250 psig 506 F straight condensing.

Condensing Equipment

One 4680-sq ft *Graham* surface condenser complete with Cameron hotwell pumps and 5400-gpm circulating reclaim pump, turbine-driven.

Feedwater System

Cochrane hot lime-soda softener rated at 192,000 lb per hr and 40,000 lb per hr of condensate with 10.6 minimum storage capacity. Two turbine-driven and one motor-driven *Pennsylvania* boiler feed pumps.

FD Fans

Two *Westinghouse-Sturtevant* 18,500 cfm fans driven at 1450 rpm by *Terry* turbines.

ID Fans

Two *Prat-Daniel* fans rated at 55,000 cfm with 7.5 in. static pressure and 486 F gas, driven by *Terry* turbines at 968 rpm and complete with *Thermix* stack.

Coke-Handling Equipment

Beaumont Birch simplex loader and skip bucket; belt conveyor to boiler house, bins or gas producer conveyor.

Ash Handling

Allen-Sherman-Hoff Hydro-Jet ash system and grab bucket sump.

Miscellaneous Equipment

Instruments—*Republic Flow Meters* combustion control and *Leeds & Northrup* for temperature.
Turbine-driven *Worthington* compressor 418 cfm,100 psig.
Fire Pump—Turbine-driven *Allis-Chalmers* 1000 gpm, 105 psig.
Crane—*Manning, Maxwell & Moore*, Shaw Box.

MIDWEST POWER CONFERENCE

MORE than fifty well selected papers and talks on various phases of power generation and use constituted the program of the Tenth Midwest Power Conference held at the Sheraton Hotel, Chicago, on April 7–9, inclusive. As in the past, it was sponsored by nine midwestern universities, the local sections of seven national engineering societies, the Western Society of Engineers and the Engineers' Society of Milwaukee, under the general direction of Prof. **Stanton E. Winston.** Space here permits a review of only a few of the papers, selected as of probable greatest interest to COMBUSTION readers.

Foreign Power Situation

Probably the best informed American engineer on European power matters is **Col. Walker L. Cisler,** executive vice president of The Detroit Edison Company, who not only was on General Eisenhower's staff as power advisor throughout much of the North African and European campaigns, but who subsequently spent considerable time, as a representative of the U. S. Government, in restoration of power services and in analyzing the whole European power situation.

In his paper on "The Foreign Electric Power Situation," Colonel Cisler reviewed briefly some of the power problems wrought by the war and then proceeded to discuss the present European power situation as it concerns the Marshall Plan for the sixteen nations involved. These nations have an extensive power program which is aimed at greatly increasing their total industrial productive capacity, as well as improving their social, economic and political recovery.

The general program is divided into two parts: (1) a *national* program calling for the installation of 21,445,000 kw; and (2) an *international* program calling for 2,306,000 kw—a total of 23,751,000 kw. The national program calls for the expenditure of an equivalent of about five billion dollars by the European countries to which the United States would contribute 300 million, or about six per cent, in materials and small equipment. On the other hand, the international program, estimated to cost about 315 million dollars, would be provided by the United States and consist of large steam and hydro generating units to the value of 200 million dollars, and the balance other equipment. The accompanying table shows how these programs are apportioned among the various countries.

MARSHALL PLAN ELECTRIC POWER REQUIREMENTS

NATIONAL PROGRAM

Country	Area Square Miles 1,000's	Population 1,000's	Proposed Additions to Generating Capacity 1948 to 1951 (or later) Kilowatts (thousands) Thermal	Hydro	Total
Austria	32.3	6,534	165	1,370	1,535
Belgium	11.7	8,092	736	12	748
Denmark	16.5	3,550	308	None	308
France	212.5	41,928	810	1,390	2,200
Greece	50.0	6,500	276	9	285
Iceland	40.5	108	-	-	-
Ireland	31.8	4,229	57	50	107
Italy	119.7	41,176	300	2,200	2,500
Luxembourg	1.0	300	32	None	32
Netherlands	13.2	8,000	260	None	260
Norway	124.9	2,809	None	600	600
Portugal	35.5	6,660	59	210	269
Sweden	173.0	6,141	50	500	550
Switzerland	15.9	4,066	95	310	405
Turkey	294.5	13,650	190	36	226
United Kingdom	88.1	45,890	6,438	None	6,438
Western Germany					
Bi-Zone (British and U.S.)	112.0	38,200	4,665	180	4,845
French Zone	.8	6,200	39	None	39
Saar	.7	800	98	None	98
Total Western Germany	113.5	45,200	4,802	180	4,982
TOTAL NATIONAL PROGRAM	1,374.6	244,833	14,578	6,867	21,445

INTERNATIONAL PROGRAM

Austria, Switzerland, Italy	-	-	-	349	349
France	-	-	-	120	120
Germany	-	-	340	-	340
Italy	-	-	75	1,422	1,497
TOTAL INTERNATIONAL PROGRAM	-	-	415	1,891	2,306
TOTAL NATIONAL AND INTERNATIONAL PROGRAMS	1,374.6	244,833	14,993	8,758	23,751

Future Electric Power Needs

A talk by **F. R. Benedict,** of Westinghouse Electric Corporation at the opening session of the Conference served to dispel any doubts as to the growth of electric demand in the United States. These demands he separated into four well-defined groups, namely, industrial, small commercial loads, residential and rural.

The application of electric power to industry today is advancing steadily, in support of which statement he cited a number of processes which have been stimulated by experience during the war. One of these is a vast increase in welding, which makes for heavy electrical demands. Others mentioned were electric furnace production of alloy steels; various applications of high frequency heating for quick drying; increased aluminum production; the prospects of still greater mechanization in coal mining methods to offset increased labor costs; and the increasing concentration of low-grade ores by electric power as the resources of high-grade ores become less and less. The present horsepower per worker in American industry he stated as 7.25, and this figure is steadily increasing.

In the field of lighting, despite the higher efficiency of fluorescent lamps, there is a marked demand for increased and better lighting in factories, stores, schools and homes, as well as on highways as a measure for greater safety.

The demand for electric appliances in the home is ever increasing and this will be amplified by an anticipated large sales volume of television sets. The heat-pump also has attractive possibilities.

On the farm there is not only a big demand for electric-driven machines of various kinds but also for quick-freeze, low-temperature boxes of large capacity.

Speaking along similar lines, with particular reference to opportunities for young engineers, at the Thursday luncheon, **A. C. Monteith,** also of Westinghouse, predicted that to meet the potential demand there would be an increase of 40 million kilowatts of installed capacity in the United States during the next ten years and 200 million kilowatts in the next thirty years. This, he believed, presented a promising outlook for young engineers who contemplate entering the power field or various electrical manufacturing lines.

An Appraisal of the Fuel Situation

Analyzing various published estimates of fuel resources, in the light of present trends, **John Van Brunt** vice president of Combustion Engineering Co., concluded that our coal reserves will last around a thousand years, or perhaps less if the annual consumption should greatly exceed the present rate. This is in contrast with the often-cited Geological Survey estimates of some years back indicating enough coal in the ground to last three thousand years. This did not, however, take into account mining losses, increase in consumption, or probable future demands on coal as a source of synthetic oil and gasoline.

The total oil and gas reserves from natural sources are estimated as not more than five per cent of the *recoverable* coal.

There is a strong probability, according to Mr. Van Brunt, that by 1957 little oil or gas will be used for steam generation, except perhaps in certain restricted localities. By that time, the influence of more efficient power stations, now in the design stage and others to be laid down, will have reduced the average utility coal consumption for the country to perhaps 1.2 lb per kw-hr which will help to conserve fuel, in face of a continued increase in output. On this basis it was suggested that coal consumed by electric utilities at that time may reach around 145 million tons annually, as compared with 86 million tons in 1947 which figure was a 25 per cent increase over 1946.

Coal for industry should parallel its use by utilities but at a slower rate.

Commenting upon the general decline in coal quality for steam generation purposes, during and since the war, the speaker was of the opinion that, in general, utilities will continue to find it expedient to burn mostly slack that passes through $1^1/_4$-, $^3/_4$- or $^1/_4$-in. screens, the quality of which may become lower by inclusion of washery refuse.

However, manufacturers of steam generating equipment have kept pace with declining coal quality, and units are now operating daily without interruption with coal of 10 to 12 per cent moisture, 15 to 18 per cent ash and with ash-fusion temperature of 1950 F. Also, recent developments in furnace and burner design for pulverized-coal-fired units have made it possible to extend the range of superheat and reheat control.

The Trek of Industry Westward

Departing from the usual technique of power conference papers, **John M. Drabelle,** chief engineer of the Iowa Electric Light & Power Company, in a paper entitled "The Trek of Industry Westward," reviewed the factors influencing the country's industrial development in various sections from colonial days, through intervening eras, down to the present.

Today there appears a definite trend on the part of industry to decentralize, and much of it is looking westward for more favorable locations, with preference for cities under 50,000 population. Many communities, railroads and power companies are bidding for new industries. The Central Region, comprising the states of Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio and Wisconsin, leads in the number of new plants or plant additions constructed since VJ Day. Of these, 490 out of 714 plants, as well as the greatest invested capital, are located in Illinois, Indiana, Michigan and Ohio which have neither personal income nor corporation income taxes. Viewed nationally 30 of the 48 states levy personal income taxes and 26 have a corporation tax. The burden of tax accounting appears to be an important factor as well as the amount of the taxes in industry location.

Experiences With Multiple Fuel Firing

F. H. Hollis, of the Alton Box Board Company, presented the operating record, from November 1, 1944, to January 1, 1948, together with a detailed account of experiences when burning pulverized coal, oil and natural gas, singly and in different combinations in the furnace of a 100,000-lb per hr, 475-psig, 750-F Riley steam generat-

ing unit. The coal ranges in moisture from 10 to 20 per cent, the ash 10 to 22 per cent, 55 grindability, 2000 to 2100 F ash-fusion temperature and 9500 to 11,400 Btu per lb. Natural gas is used when available and the fuel oil is a residual product obtained from a nearby refinery, a steam-atomizing burner being employed.

The unit is frequently subjected to a load of 140,000 lb per hr for short periods and on one occasion carried 150,000 lb per hr for three hours when burning a combination of coal and gas, and later coal and oil.

When first placed on the line with natural gas at loads up to 120,000 lb per hr the furnace was relatively dark but brightened as pulverized coal was cut in. However, coal ignition with the gas cut out was not stable and it was concluded that the furnace was too cold. To remedy this the front wall tubes, which are on 6-in. spacings, were studded for a considerable area around the burner ports and this area covered with chrome refractory. Also, the coal tube was shortened to bring the coal stream closer to the refractory ring. These changes effected a vast improvement, but ignition on coal alone is still not stable below a rating of 45,000 lb per hr. When gas is admitted at the minimum flow of 25,000 cu ft per hr the coal flame becomes stable throughout the entire load range. The coal flame is likewise stable when supplemented with oil.

When firing combination coal and gas the contour of the flame is different from that when firing either fuel alone for a distance of about a third out from the front wall, after which it is difficult to determine any particular difference. The effect of the gas flame is to constrict the coal flame. A similar change is noticed when burning a combination of coal and oil, or gas and oil. No difficulty whatsoever has been experienced in combination firing either in pairs or all three fuels, although it is quite apparent that ignition conditions show the greatest stability when some gas is being burned.

When firing a combination of coal and oil under heavy sustained loads for three weeks or more, slag accumulates on the side and rear walls and becomes quite incandescent. However, it can be readily removed with an air lance. When gas becomes available in large quantity and the other fuels are correspondingly reduced, the furnace shows evidence of cooling down and the particles of slag begin to spall off.

Steam costs, including fuel, labor, maintenance, supplies, overhead, taxes, etc., for the last three years, were as follows:

	Steam Made M Lb	Fuel Cost per M Lb Steam	All Other Costs per M Lb	Total Cost per M Lb Steam
1945	902,944	$0.1745	$0.1197	$0.2942
1946	970,323	0.1962	0.0589	0.2551
1947	977,448	0.2680	0.0719	0.3399

The average boiler efficiencies were 83 to 84 per cent on coal, 80 to 82 per cent on gas and 80 per cent on oil.

Furnace Design

In a comprehensive paper on "Furnace Design Methods, With and Without Water Walls," **Ollison Craig,** of Riley Stoker Corporation, after reviewing the fundamentals of furnace design, listed certain design factors and tabulated a range of values for each with various types of fuel burning equipment and with fuels of different characteristics and different fractions of furnace cooling. These factors were:

1. Grate area
2. Furnace volume
3. Furnace height (grates to tubes)
4. Rear arch coverage
5. Front arch coverage
6. Height of rear arch above grates
7. Height of front arch above grates
8. Furnace cooling
9. Length of furnace
10. Distance—burners to tubes
11. Distance—burners to furnace

Space here will not permit reproduction of the tabulation, but for illustration, the following values are quoted for a few:

1. With single-retort stokers the heat release per cubic foot per hour ranged from 30,000 to 45,000 Btu (according to the amount of wall cooling) for coal with 2200 F ash-fusion temperature; and 40,000 to 50,000 Btu with 2400 F ash-fusion temperature—each based on 13 per cent CO_2 in the furnace exit gases.

2. With traveling grate stokers burning No. 4 buckwheat the Btu release per cubic foot ranged from 39,000 to 33,000, according to the burning rates. Rear arch coverage ranged from 55 to 67 per cent of the stoker length, and front arch coverage from 20 to 25 per cent, depending on the stoker length. Front arch heights were given approximately as $8^1/_2$ ft above the grate for all capacities and rear arch heights (single-arch design) ranged from 3 ft for 50,000 lb per hr units to 4 ft. 3 in. for 200,000 lb per hr units.

3. With spreader stokers the furnace heat release ranged from 30,000 to 35,000 Btu per cu ft per hr for refractory furnaces and 30,000 to 40,000 Btu for fully water-cooled furnaces.

4. For pulverized coal of 1900 F ash-fusion temperature the heat release was 8500 Btu with an all-refractory furnace and 17,600 Btu with a completely cooled hopper-bottom furnace. The corresponding values for 2400 F ash-fusion coal were 17,000 to 26,000 Btu per cu ft per hr.

5. With oil firing the range was from 18,000 to 40,000 Btu per cu ft per hr, depending upon the capacity of the unit and the Btu per hr per sq ft of projected tube area.

6. For gas firing these values ranged from 27,000 to 35,000 Btu.

Application of Heat Balance Analysis to Industrial Plants

Asserting that a heat-balance analysis is essential as a basis for the study of improvements in industrial plants involving use of process steam at various pressures, hot and cold water and electricity, or a decision to purchase power, **H. C. Carroll,** of Commercial Testing and Engineering Company, Chicago, proceeded to outline the necessary procedure for making such an analysis.

If complete records over a sufficient period of quantities, pressures, temperatures, and characteristics of demand for steam and electricity are available, it is a simple matter to construct a heat balance. However, few of the older plants have these figures at hand. Some are partly equipped with metering devices and these must be supplemented; but where there are no

such instruments permanently installed, portable recording and indicating test meters must be employed to measure the essential quantities. This will involve a working knowledge of steam lines (live and exhaust) and water lines, as well as the electrical distribution system for which purpose single-line diagrams should be made in order to locate properly the various instruments.

With data thus obtained decisions can be reached as to the proper steps to be taken to improve the existing heat balance or to provide for contemplated changes. If consideration is being given to new steam and electrical generating units, the survey data will dictate the selection of proper initial pressures and temperatures, as well as types, such as condensing, non-condensing or extraction units and the most advantageous bleed pressures and temperatures. The savings to be effected by the necessary investment will be indicated.

Where a plant is small a preliminary inspection may suffice to indicate possible savings, but where a number of services and processes are involved it may be impossible to correlate them without making actual measurements. Furthermore, according to Mr. Carroll, experience has shown that the cost of an analysis as outlined is usually very small compared with annual fuel costs and the benefits to be derived with a properly designed layout, whether a new plant or an old one undergoing major changes.

Boiler Water Treatment

A practical approach to this subject was contained in a paper by **Dr. R. C. Ulmer**, of E. F. Drew & Company, who first stressed the importance of proper diagnosis before giving consideration to how a feedwater problem is to be solved. He cited cases to illustrate this contention. Standardization in terminology and in methods of sampling and reporting results would lead to better understanding.

Once the problem has been properly diagnosed the solution is usually quite simple. In most cases ordinary scale and deposits can be eliminated by maintaining proper alkalinities and/or phosphates, although supplemental treatment is often necessary. In this connection, "organics" are being widely used to supplement straight chemical treatment. They possess properties of making possible the removal of sludge, of making the remaining sludge non-adherent, and of preventing the formation of certain deposits, especially siliceous types.

It is also important to maintain the necessary tolerances, or concentrations in various ions, especially with reference to alkalinity and phosphate, which are best used separately in order to facilitate control. Proper control involves not only regular dosages and analyses, but also attention to the results obtained which are best observed by graphical methods.

In many small and medium size plants the proper feedwater treatment is not applied regularly, in which case an automatic type feeder is most desirable.

Maintenance of even concentration of solids in the boiler water tends to decrease the possibility of carryover as well as to minimize thermal losses from blowdown. Although continuous blowdown aids in improving conditions over those attainable with intermittent blowdown, considerable variation may still occur if there is wide variation in boiler load or in water conditions. To eliminate these possibilities, continuous blowdown based on electrical conductance can be used.

Finally, a means for indicating steam purity is most desirable.

High Alkalinity and Organic Material for Sludge Removal

The South Omaha Steam-Electric Station contains three 200,000-lb per hr C.E. two-drum steam generating units, burning natural gas with oil standby, and supplying steam at 450 psig, 750 F to a 5000-kw G.E. turbine-generator. Extracted and exhaust steam is supplied, through transport lines, to three large packing plants for refrigeration, process and heating, at 175 and 30 psig. No condensate is returned from the customers, as a result of which makeup requirements for the plant average 85 per cent of the water fed to the boiler. The makeup is Omaha city water, originating from the Missouri River and previously treated by sedimentation, coagulation and filtration.

Experience with the boiler-water problem at this plant was related in a paper by **Selden K. Adkins**, chemist of the Omaha Public Power District.

At the plant the city water is further treated in hydrogen-sodium Zeo-Karb units, with subsequent degasification and aeration by means of an Elliott tray-type deaerator. The feedwater then has the following composition:

Hardness, as $CaCO_3$	1–5 ppm
Dissolved solids	230–500 ppm
Sulphate, as Na_2SO_4	170–400 ppm
Chlorides, as NaCl	15–35 ppm
Silica, as SiO_2	7–14 ppm
Alkalinity to M. O.	10–16 ppm
pH	8.1–8.4

The final treatment is applied directly to the boiler drums with positive-displacement, adjustable chemical pumps. Continuous blowdown, incorporating two-stage flash vapor recovery and a heat-exchanger, provides for concentration control.

Excessive sludge deposition became a problem soon after the plant was started and tests showed boiler water concentrations above 2500 ppm. Alkalinities were maintained at the lowest level compatible with a pH of 10.4 and PO_4 excess of 20 to 30 ppm, and for a period of several years thereafter supplementary treatment consisted of sodium hydroxide and tri-sodium phosphate. Later other additives were tried to condition the sludge but without success, with the result that the boilers had to be taken out of service for cleaning seven to ten times a year.

Then from October 1944 to June 1946 acid cleaning was substituted for mechanical means, but an inspection as of the latter date showed signs of acid-etching; so the acid cleaning was discontinued.

Next, it was decided to increase the hydroxide alkalinity by increasing the ratio of NaOH to Na_3PO_4, with excess PO_4 being continued at 30–40 ppm. After some false indications resulting in further modifications, operators were instructed to feed supplementary chemicals

at a rate sufficient to maintain 200–220 ppm alkalinity to M. O. Subsequent inspections showed only small amounts of residual sludge, most of which could be removed by simple washing with 200 psi hose pressure.

Based on these encouraging results, hydroxide alkalinity was again increased by adjusting the sodium hydroxide–trisodium phosphate ratio in the supplementary chemical mixture to maintain 250–270 ppm.

A further step was the introduction of a processed lignin derivative into one of the boilers after the November 1946 washing, and when the unit was later inspected the internal surfaces had the appearance of having merely been dusted with finely divided phosphate sludge. Therefore, the organic treatment was applied to the other boilers with the result that the number of cleanings has now been reduced by more than 60 per cent.

Iron in Feedwater

Prof. F. G. Straub, of the University of Illinois, reported on a survey conducted last year, and still under way, in several large power plants in an attempt to account for and remedy the pickup of iron in the feedwater cycle. Several of these plants have experienced attack on the boiler feed pumps and excessive amounts of iron oxide accumulations on the boilers.

Samples were taken in one station of the steam leaving the boiler, the condensate at the condensate pumps, and the feedwater at the boiler feed pump; and the relationship between the pH and the iron content noted. It was found that the pH of the steam, when below 7, increases as the water passes through the system, with accompanying increase in iron content. The ammonia content remained constant, consequently the pH increase was apparently caused by the dissolved iron. As the pH of the steam increases the rate of iron pickup decreases, so that when the pH of the steam was almost 9 in this station there was no iron pickup at the condenser, and between the condenser and the feed pump there was very little.

In two other stations samples were taken of the superheated steam, condensate from the condensate pumps, and after deaeration. Similar results were obtained as in the first station but with a smaller degree of pickup.

The results indicate that pH control of the feedwater is not the answer to the prevention of iron attack. In order to have determined whether a feedwater is aggressive to iron it is necessary to ascertain the iron and ammonia content as well as the pH. Once these data are available the advisability of modifying the pH value may be readily determined.

Causes and Prevention of Condensate Return-Line Corrosion

Recalling that as early as 1924 corrosion of steel in the presence of carbon dioxide and oxygen in condensate had been recognized and further verified by studies conducted in 1939 in condensate return systems at very low carbon dioxide concentrations and high flow rates, **R. T. Hanlon,** of National Aluminate Corporation, cited field experience in a number of cases to show that reduction or neutralization of carbon dioxide content has reduced condensate line corrosion to a negligible problem. While in some cases it has also been possible to reduce the oxygen content, in many plants this is not possible because of system design, particularly with vacuum-return systems or those subjected to intermittent operation, where oxygen in leakage is probable.

Carbon dioxide in condensate can originate from several sources, including (1) boiler makeup water that contains a high concentration of calcium, magnesium or sodium carbonate, or high makeup of water containing moderate concentrations of these compounds; (2) failure to employ a deaerator; (3) improper chemical treatment or control of boiler water; and (4) improperly designed or poorly operated makeup pretreatment system. Regardless of how bicarbonate is combined, it breaks down in the boiler and liberates carbon dioxide. This occurs regardless of operating pressure.

Evaporators do not substantially reduce the carbon dioxide input because the bicarbonate is broken down in the evaporator, as in the boiler, and liberates carbon dioxide in the evaporator vapor.

Lime-soda softeners, either hot or cold, afford some reduction in the bicarbonate content of makeup water.

In base-exchange systems using acid or acid and brine for regeneration of the softening materials, the bicarbonate entering the softener is converted to carbon dioxide and is removed as a gas in the degasifier. With such systems it is possible to reduce the bicarbonate content of the degassed water to zero and the carbon dioxide content to less than 5 ppm. Removal of the carbon dioxide by aeration in the gas-removal chamber, however, saturates the treated water with oxygen. Therefore, it is most essential that a properly designed and operated deaerating heater or deaerator be employed for removal of the oxygen.

The author's conclusions were that condensate return-line corrosion can be substantially reduced in low-pressure plants by employment of water-treating equipment designed to remove free and combined carbon dioxide from boiler makeup by neutralization of carbon dioxide with amines; or by development of a protective film through use of polyphosphates.

In the case of high-pressure units, the feedwater must be essentially free of carbon dioxide and oxygen in order that attack upon ferrous materials of the preboiler system will be reduced and minimum iron admitted to the boilers.

Where iron-oxide deposits occur in high-pressure boilers, it has been found necessary to acid wash or otherwise clean the boilers at frequent intervals to remove such deposits and prevent tube losses. Such tube losses have also been prevented by reduction of the hydrate alkalinity of the boiler water or by treatment of the boiler water with a lignin derivative to prevent deposition of magnetic iron oxide.

Electric Power in Japan

Interesting information and figures on the Japanese Electric Power System were contained in a paper by **E. J. Burger,** vice president of The Ohio Public Service Company, who spent over four months in Japan on a power survey mission for the Secretary of War.

The Japanese power system serves the four main islands upon which live about 75 million people, and at the end of 1947 amounted to 10,198,000 kw installed capacity. Of this, 8,846,000 kw represented the public utility system which is predominately hydro.

In 1939, by government decree, practically all the operating companies supplying utility service were merged into a single company, the Nippon Hassoden Company, which, while privately owned, is managed by officers and directors selected by the Ministry of Commerce and Industry.

The public utility system comprises 1284 hydro plants (the largest of 195,000 kw) of 5,900,000 kw total capacity and with a current annual output from steam and hydro of over 31 billion kilowatt-hours. The hydro plants are located mostly in the mountainous sections of the North and connected by transmission lines with the industrial areas where the steam plants are located. On Honshu the latter are used to augment hydro generation for about four months of the year; but on the island of Kyushu the base load is carried on the steam plants.

The largest steam plants are two located in the Osaka area. One, completed in 1936, has six 50,000-kw units operating at 597 psi, 833 F; and the other, completed in 1941, has four 75,000-kw units operating at 639 psi, 847 F. Nearly all the turbine-generators in the later plants were manufactured in Japan where two companies, Mitsubishi and Ishikiwajima-Shiboura, dominate the field. The peak generation of the electric power system was reached in 1943 when 38 billion kilowatt-hours were produced.

Before and during the war Japan itself produced about 50 million tons of coal annually, the mines being worked by Chinese and Koreans. Since these foreign workers have been repatriated with termination of the war, the Japanese have been reluctant to work underground and production fell off. Moreover, the quality of the coal has deteriorated and now averages about 9000 Btu per lb.

During the war no damage was inflicted on any of the hydro plants and only one of the large steam plants was damaged by bombing.

Power Plant Operator Training

A session on this subject, under the chairmanship of **J. P. Flynn,** president of the National Association of Power Engineers, consisted of the four following papers:

"Training Operating Engineers," by **Garrett Burgess** of Detroit, one of the pioneers in educational activities of the N.A.P.E.

"Why and How of Operator Training," by **Kenneth R. Hodges,** Editor of *National Engineer.*

"Training Power Plant Personnel," by **Stephen C. Casteel,** of the St. Louis & Interurban Water Company.

"A Training Program for Custodians and Boiler Operators," by **Julius Barbour,** of East Lansing, Mich.

"The main obstacle encountered in training operators and engineers," said Mr. Burgess, "is securing recognition of their responsibility. Billions of dollars worth of fuels are consumed annually at efficiencies far below those attainable with properly trained operators, and it therefore behooves us to encourage every training program."

He pointed out that the problems of the power plant engineer are increasing continuously, with responsibilities becoming more diversified. This is particularly true with reference to new designs of boilers and prime movers, involving higher pressures and temperatures, the greatest economy of which is attainable only if the potential efficiency is realized.

The paper concluded with a brief outline of the training programs offered by the N.A.P.E. as conducted by both the national organization and the individual chapters. These comprise study courses conducted by instructors at regular meetings; courses conducted in collaboration with local educational institutions or extension courses of universities; film and slide lectures; question and answer forums; power plant visits, etc., culminating in the issue of a "Certificate of Competency" by the National body, after checking by the National Examining Committee.

Mr. Hodges listed as objectives for organized training programs of power plant operators, the attainment of higher efficiency, increased reliability and availability, and plant safety. As an intangible return, better men can be procured for power plant work and the standing of such employees is enhanced, in their own estimation, in that of their fellow workmen, and in the opinion of management.

In this connection the labor market, during and since the war, has been such that management has had to attract new men, promote and upgrade men already employed, and raise salaries. The increased fuel costs and salaries have served to raise operating costs which, in many cases, can be offset, or partly so, by more efficient operation.

Mr. Casteel remarked that too often those in authority expected an understanding of such terms as fuel-air ratio, CO_2, etc., to be within the scope of those in higher positions only, whereas the logical place for application of such knowledge is at the equipment. He followed with an outline of the training program employed by his company to prepare the younger men for added responsibilities; and stressed the point that the success of any such training program depends largely upon the ability and enthusiasm of the instructor, not only to teach those interested in self-improvement, but also to establish an atmosphere of mutual group interest and to encourage individuals who are shy or backward.

Mr. Barbour's paper concerned chiefly the history and experience of on-the-job training for Michigan school custodians and boiler operators as at present directed by the State Board of Control for Vocational Education in collaboration with Michigan State College.

Gas Turbine Test

Performance and test results with a 2000-hp Westinghouse gas turbine, operating approximately 1000 hr, were reported by **T. J. Putz.**

The overall fuel rate at full load on test was 0.78 lb per bhp-hr, corresponding to a thermal efficiency for the unit of 16.7 per cent based on the higher heating value of the fuel—19,500 Btu per lb. The maximum capacity developed was 2350 hp when operating with an air inlet temperature of 34 F. Adiabatic compres-

sion efficiency of the compressor varied from 80 to 86 per cent.

The unit was started 350 times and has undergone several thousand rapid load cycle changes from no load to full load. Starting is accomplished by one generator being used as a motor, the time (1 to 8 min) depending upon the starting power employed. When the rotor reaches 15 per cent speed, the acetylene igniters are turned on and at 25 per cent speed the oil fuel is injected.

It was found that the compressor becomes fouled with oily deposits that cause a drop of about 2 per cent in efficiency after around 100-hr operation. Hence it then becomes necessary to wash the compressor blading.

There have been two mishaps, the first a failure of turbine blading after 57-hr operation, due to rubbing during rapid temperature changes; and the second a failure of stationary compressor blading after 125-hr operation, due to fatigue from vibration at the blade roots.

No. 3 furnace oil was used as fuel during most of the testing. When Bunker C oil was tried the fuel rate increased about 8 per cent and some erosion of the fuel nozzle occurred.

None of the heated parts of the unit has shown signs of distress, and there has been no measurable creep of any stressed high temperature part.

A. P. Darlington, of American Blower Corp., in a paper on "Mechanical Draft Fans" discussed requirements of forced- and induced-draft fans for steam-generating stations. This paper will be reproduced in the May issue.—Editor

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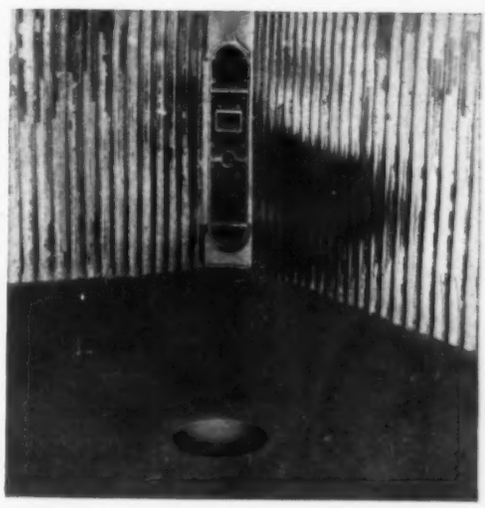
Eighteen tons of R & I Moldit Chrome Refractory Cement were shot by a cement gun into the floor of a slagging bottom boiler in only 3½ hours, or 35 man-hours.

It previously took 661 man hours to pound and hammer eighteen tons of plastic chrome in the same floor. Boiler outage was thus greatly reduced by using Moldit Chrome.

A bridge wall 28-ft. wide by 14-ft. high by 18 inches thick was burning out in a stoker, over fired by oil, every three weeks. Brick and super-duty bricks of all kinds were tried without luck. Finally, keys were made in the wall and R & I Moldit Chrome shot 2 inches thick over the face. This increased the life of the wall six times.



Slagging bottom boiler, showing tap hole in floor where slag runs out. Moldit Chrome was shot over tubes in floor.

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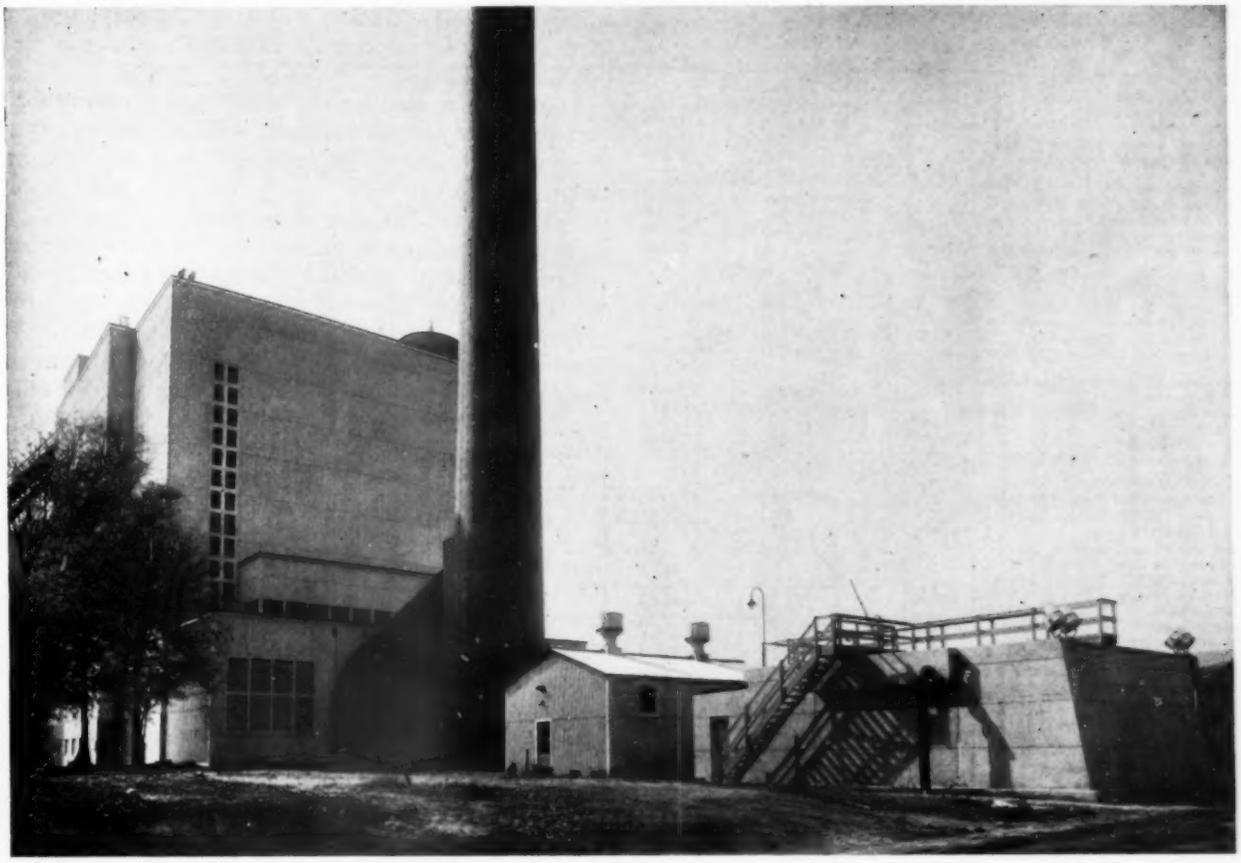


Chesterfield Power Station with water treatment plant in right foreground

Two Years Performance of the Chesterfield Power Station

The outstanding feature of the performance of this station, part of the Virginia Electric and Power Company system, is the high availability. For the year 1947 this was 98.0 per cent for the boiler and 98.5 per cent for the turbine. Other high points of the 1947 operation were a net station heat rate of 11,922 Btu per kwhr and a station makeup of 0.864 per cent.

By R. S. Reed

Stone & Webster Engineering Corporation

THIS station[1] was described in the November 1944, issue of COMBUSTION, but it may not be amiss to review certain features that were brought out therein. The initial installation consisted of a single 50,000-kw G-E turbine-generator, having an overload capacity of 62,500 kw at unity power factor. Steam was supplied at 875 psig and 900 F at the superheater outlet by a Combustion Engineering pulverized-coal-fired steam generating unit of 525,000 lb per hr rated capacity (four hour peak of 575,000 lb per hr). Superheat was satisfactorily controlled by vertically adjustable tangential burners in conjunction with a bypass damper.

Because of the critical shortage of many wartime items, certain substitute materials were employed. Structural steel was kept to a minimum by the extensive use of reinforced concrete and also by the use of wood in places where it would not introduce any dangerous fire hazard. The coal bunkers, and supporting columns were made of concrete. Circulating water supply lines from the intake house to the main building utilized precast 48 in. concrete piping. Further savings of iron products were made by the use of electrical non-ferrous tubing and

[1] Engineered and constructed under the supervision of Stone & Webster Engineering Corporation, Boston.

OPERATING FIGURES FOR 1946 AND 1947
CHESTERFIELD POWER STATION

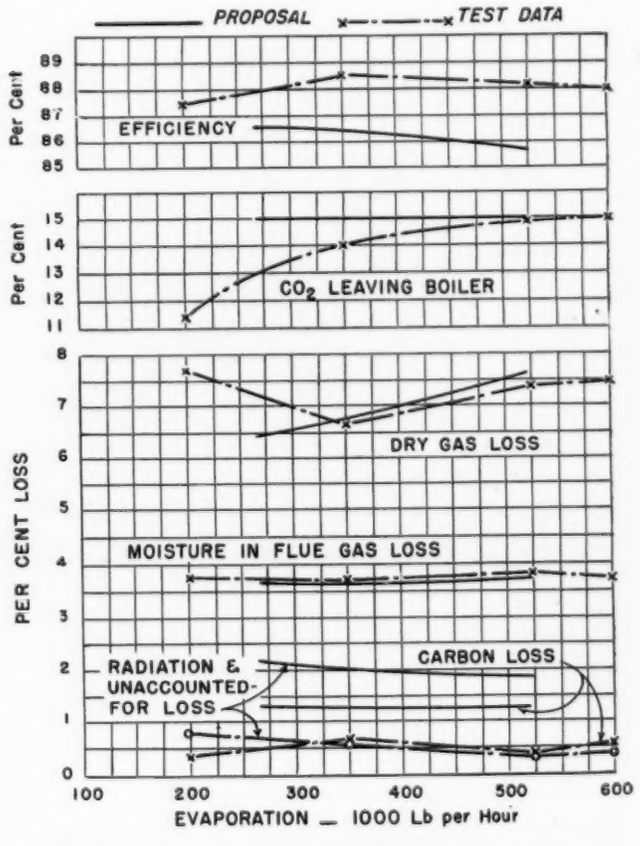
Item	1947	1946
Electric Generation		
Total kwhr generated	477,621,000	382,699,000
Station power, kwhr	30,514,800	25,522,000
Total kwhr generated, net	447,305,900	357,571,200
Station power in % total power	6.347	6.566
Steam Generation		
Total steam generated, lb	4,360,571,000	3,471,158,000
Total auxiliary steam, lb	54,120,000	86,150,000
Steam to turbine, lb	4,306,451,000	3,385,008,000
Auxiliary steam in % total steam	1.241	2.482
Fuel Consumption		
Fuel oil used, gal	200,078	2,012,731
Coal equivalent, lb	2,079,800	20,169,700
Coal used in auxiliary heating boiler, lb	37,200	120,000
Coal used in No. 1 boiler, lb	399,363,400	289,646,780
Coal equivalent for station operation, lb	401,480,400	309,816,480
Station Heat Consumption and Efficiency		
Coal per net kwhr	0.898	0.866
Heat value of coal, Btu per lb as fired	13,276	13,771
Btu per net kwhr	11,922	11,926
Station efficiency, %	28.63	28.62
Station water rate, lb per kwhr	9.749	9.708
Boiler Plant Operation		
Average steaming rate, lb per hr	510,851	429,206
Boiler efficiency, %	88.1	89.26
Steam pressure, psig	859	861
Total steam temperature, F	896	891
Feedwater temperature, F	399	377
Gas analysis, % CO_2	14.7	14.0
Carbon in fly ash, %	4.80	12.65
Coal fineness, % through 200 mesh	76.66	77.08
Preheater outlet air temperature, F	622	598
Preheater inlet gas temperature, F	777	717
Preheater outlet gas temperature, F	379	363
Boiler blowdown, % total steam	0.35	0.40
Average boiler water total conc., ppm	171	167
Max. boiler water total conc., ppm	417	268
Number of outages periods	6	11
Hours steaming	8,535.9	8,087.4
Hours out	224.1	672.6
Hours available for service	8,583.8	8,304.8
Availability factor, %	98.0	94.8
Average Boiler Water Analysis		
Alkalinity, ppm	80	80
Chlorides, ppm	1	1
Phosphate, ppm	41	35
Silica, ppm	1.8	1.6
Sulphate, ppm	...	...
Sulphite, ppm	...	...
Turbine Operation, No. 1 Unit		
Average load, lb steam per hr	504,510	418,553
Water rate, lb per kwhr	9.016	8.845
Condenser circulating water temp., inj., F	62	63
Condenser circulating water temp., disc., F	72	71
Exhaust temperature, F	94	89
Vacuum, in. Hg	28.558	28.830
Conductivity of condensate, micromhos	1.51	1.60
Oxygen content of condensate, cc per L	0.014	0.013
Throttle pressure, psig	852	855
Throttle temperature, F	891	886
Hours operated	8,535.9	8,087.4
Hours off line	224.1	672.6
Hours available for service	8,629.3	8,361.0
Availability factor, %	98.5	95.4
Generator Operation, No. 1 Unit		
Average hourly output, kwhr	55,954	47,320
Max. hourly output, kw	70,000	69,000
Generator loading factor, %	111.91	94.64
Machine hydrogen pressure	71.3	21.4
Avg. hydrogen makeup, cu ft per day	119.63	87.18
Hours operated	8,535.9	8,087.4
Hours available for service	8,760.0	8,453.0
Availability factor, %	100.0	96.5
Evaporator Operation		
Total station makeup	37,688,300	46,957,200
Station makeup in % total steam	0.864	1.353
Feedwater Heater Operation		
Temp. water to No. 1 heater, F	90	86
Temp. steam to No. 1 heater, F	190	188
Temp. water from No. 1 heater, F	185	177
Temp. steam to No. 2 heater, F	387	348
Temp. water from No. 2 heater, F	295	281
Temp. steam to No. 3 heater, F	675	629
Temp. water from No. 3 heater, F	399	371
Temp. No. 3 heater drip, F	351	319
Water temp. to heat exchanger, F	62	63
Water temp. from heat exchanger, F	97	102
Station Loading and Operating Factors		
Generator nameplate capacity, kw	50,000	50,000
Boiler nameplate capacity, lb steam	25,000	525,000
Max. daily output, net, kwhr, 2/28/47	1,439,200	1,374,400
Average hourly output, net, kwhr	52,403	44,213
Load factor, %	79.28	64.08
Capacity factor, %	104.81	88.43
Demand factor, %	140.00	138.00
Proximate Coal Analysis		
Moisture, %	5.03	4.59
Ash, %	8.75	6.77
Volatile matter, %	25.95	23.23
Fixed carbon, %	60.27	65.41
Btu value, dry	13,979	14,433
Btu value, as received	13,276	13,771
Fusion temp. ash, F	2673	2718
Fluid temp. ash, F	2778	2820
Grindability, hardgrove	79	87
Sulphur, %	0.87	0.82

transite conduit. Rubber was saved by employing synthetic varnished cambric or oil-based compound insulation for all wiring.

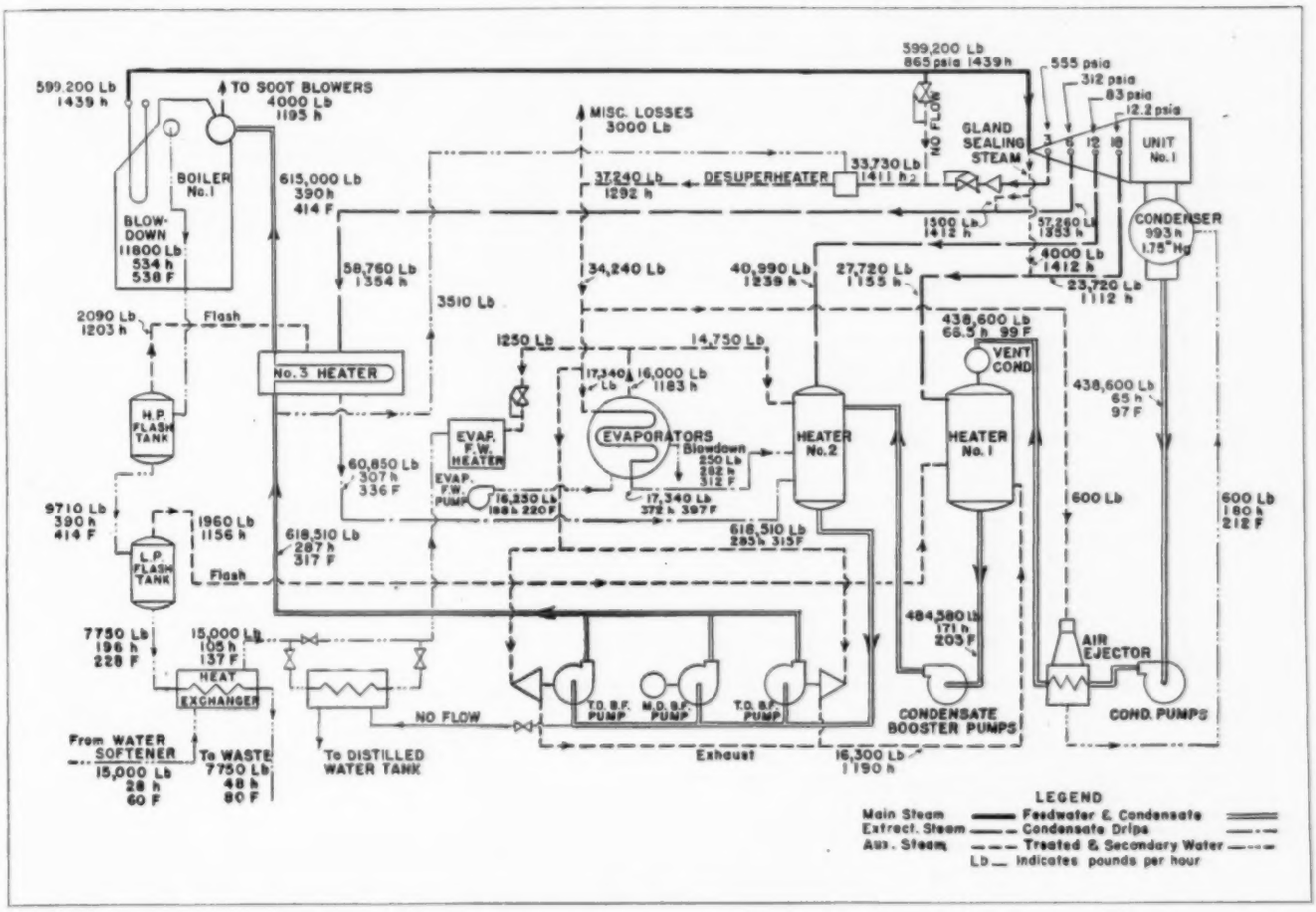
Transite was used for the boiler casing, siding for the coal conveyor and the building walls. After nearly four years of operation the selection of these substitute materials has proved to be sound, for there have been no maintenance problems or undue wear as a result of using these materials, and fire hazard has not proved serious.

The first extension to the Chesterfield Power Station is now in progress. This will consist of a boiler and turbine-generator of somewhat greater capacity than the first. That is, the C-E steam generating equipment, similar in design to the first unit but a little larger, will be capable of supplying 650,000 lb of steam per hour continuously (4-hr peak of 700,000 lb) while the G-E turbine-generator will have a nameplate rating of 60,000 kw. The latter will conform to the A.I.E.E.-A.S.M.E. Preferred Standards for large steam turbine-generating units. It is expected this additional capacity will be put into operation during the fall of 1949.

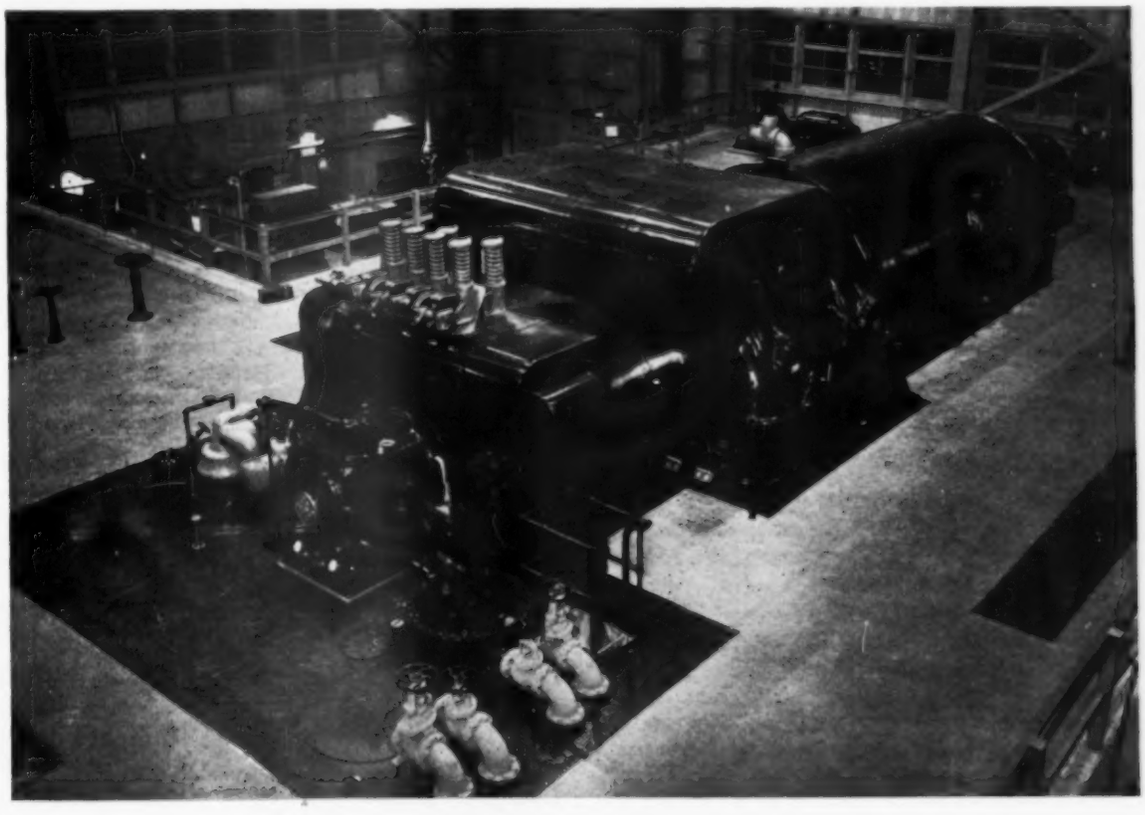
The accompanying tabulation gives the station performance for 1946 and 1947. An outstanding achievement of this record is the high availability factors for the boiler and the turbine-generator. The boiler showed an increase from 94.8 to 98.0 per cent, while the turbine increased from 95.4 to 98.5 per cent for the period. Thus the availability of boiler and turbine are comparable and justify employment of the unit arrangement. This was accompanied by an increase in the average hourly output of electricity from 47,320 kwhr to 55,954 kwhr, which resulted in an increase in yearly output of about 25 per cent.



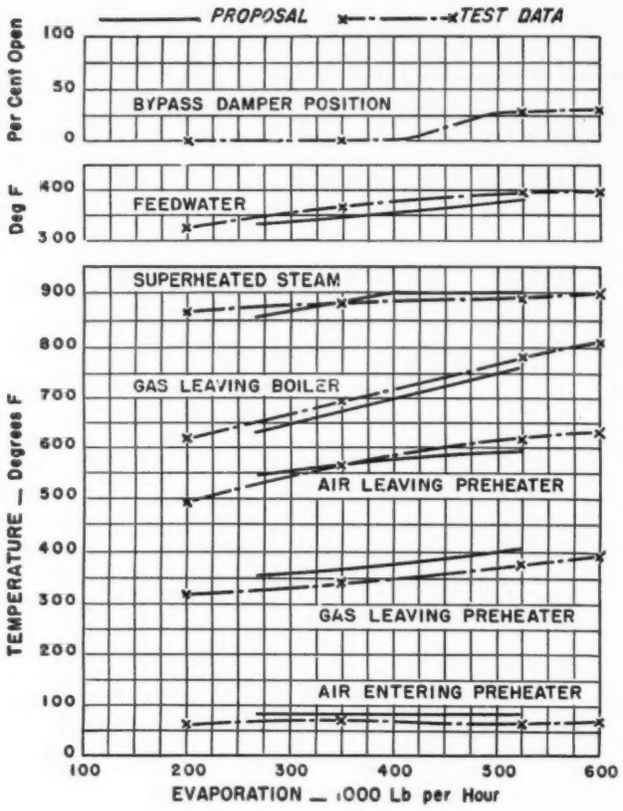
Comparison of calculated and test performance



Station heat balance of 63,215 kw load



50,000-kw turbine-generator



Boiler temperature over wide load ranges

It is to be noted that the boiler and turbine-generator have operated successfully at loads well in excess of the maximum guarantees. Steam loads of 640,000 lb per hr and electrical loads up to 70,000 kw have been carried. The station heat balance diagram for a 63,215-kw load with the boiler producing 599,200 lb per hr is here shown.

Coal quality has declined, not only since the plant was first put in service but also during the last two years, the average heating value going from 13,771 Btu in 1946 to 13,276 Btu per lb as fired in 1947. This was accompanied by a decrease in Hardgrove grindability from 87 to 79. Due to lowered quality, the coal per kilowatt-hour increased from 0.866 lb to 0.898 lb. The yearly average station heat rate remains about constant at 11,922 Btu per kwhr. This corresponds to a station efficiency of 28.63 per cent.

Power required for operation of the station was only 6.347 per cent of the total generated in 1947. Also notable was the decrease in station makeup from 1.353 to 0.864 per cent. This was considerably below the 3.5 per cent originally calculated. All boiler feedwater makeup, which originates from the James River, is clarified and softened. This water passes through heat-exchangers on its way to the evaporator feedwater heater. Adequate internal treatment of boiler water has resulted in keeping corrosion and deposits to a minimum.

While the foregoing data relate to performance for the years 1946 and 1947, it may also be of interest to note two charts from the boiler acceptance test made in 1945. One of these shows various temperatures plotted against evaporation, and the other efficiency and different losses also plotted against evaporation. In both cases the test data surpassed the anticipitated performance.

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COURT DECISIONS AFFECTING POWER PLANTS

By LEO T. PARKER

Attorney at Law, Cincinnati, Ohio

DURING 1947 the higher courts in different states rendered many important decisions directly or indirectly involving steam power plants, officials and employees. Knowledge of the cause and outcome of these suits should prepare readers to avoid similar legal controversies and assist in winning unavoidable suits. Those who desire to read any decision in detail may refer to the citation, and obtain the full decisions from any good library.

Steam Fitters v. Plumbers

Courts have held that a steam fitter cannot do plumbing work in a city unless he obtains a plumber's license issued by the city. For illustration, in *Commonwealth v. Dougherty, 40 Atl. (2d) 902*, it was shown that a law specifies a heavy penalty for all persons who do "business or work of plumbing and house drainage" without obtaining a license.

In the case at issue certain steam fitters were engaged in construction work in an industrial power plant. An 8-in. water main carried city water from the street to a 4-in. connection running along the ceiling of the basement of the plant. The latter pipe had been installed by plumbers. The steam fitters tapped a subsidiary water line which discharged into tanks. However, these steam fitters were found guilty by the court of doing plumbing work in an industrial plant without plumbers' licenses, saying:

"Improper connections, either with the city water pipes or sewage conduits, may have serious results. A statute regulating that subject is of importance to everyone in the city as all are concerned with having a pure, uncontaminated water supply and proper drainage facilities...."

On the other hand, see *Pittsburgh v. Kane, 14 A (2d) 887*, where the higher court held that it was not unlawful for steam fitters to install a pipe carrying off condensed moisture from an air conditioning unit and allow the moisture to be carried off through an open drain, the latter being properly constructed by a plumber. However, this case did not deal with direct connections with the city supply.

Therefore, according to these court decisions it would appear not unlawful for a steam fitter without a license to perform plumbing work which does not involve direct connection with a municipality's water supply; otherwise it is unlawful.

Weak Contract

According to a recent court decision a power plant company may make a valid contract with lower property owners to deposit debris, etc., into a stream above their property. However, if the contract fails to specify clearly that the company has unrestricted rights in this respect the property owner may sue and recover damages and, also, obtain a valid injunction against the company depositing its waste matter into the stream.

For example, in *Associated Company v. Superior Court, 180 Pac. (2d) 389*, it was shown that a company has owned and operated a plant on a stream above the property of Mr. Howe, for more than two years. Recently Howe brought suit against this company and sought an injunction to restrain it from discharging waters and debris into the stream, and for damages in the sum of $35,000.

The company's counsel contended that the damages to Howe were fully compensated by a previous agreement whereby the company had furnished Howe with several hundred feet of iron pipe through which he was supplied an agreed quantity of water. However, this contract between the company and Howe did not clearly specify that in consideration of the company furnishing the pipe, Howe would forever forfeit his legal rights to "any and all future damages" and legal action against the company for depositing water, debris, etc., into the stream above the property. Therefore, since the damages resulting to Howe amounted to more than the cost of the pipe furnished by the company, the court held that Howe could recover from the company the difference between the value of the pipe and the amount of damages the jury decided was due him.

Loan of Equipment

According to another higher court decision, if one contractor loans equipment to another he is liable to damages if he fails to know whether the equipment is in safe condition.

In *Bonvillain v. Operators, Inc., 26 So. (2d) 25*, the testimony proved facts as follows: The owner of a hoist loaned it to a friend. The latter was using it when it broke, and he sustained a severe injury to his back. The higher court allowed him $42,083 damages, and said:

"He (the owner) assumed a responsibility and became liable to anyone who might be injured."

Gas Company's Liability

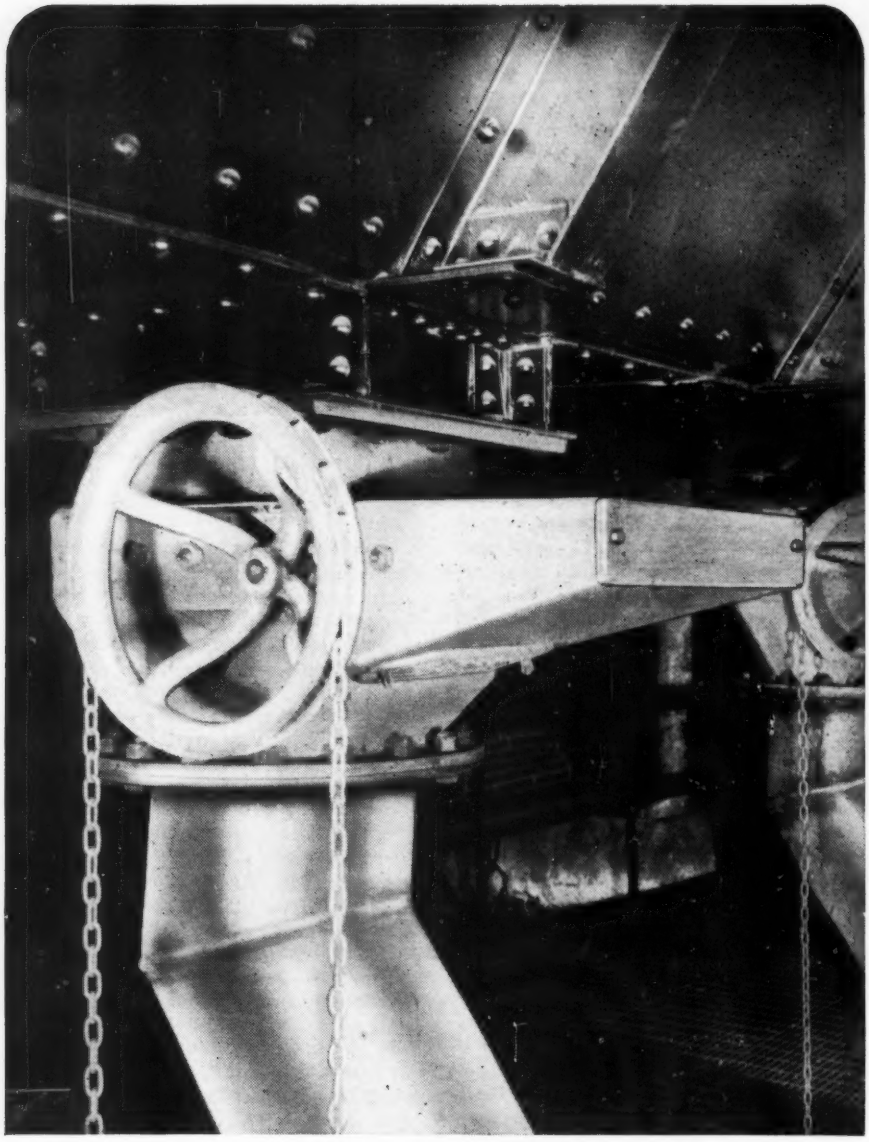
The degree of care required of a company distributing gas is well established. In dealing with this substance a high degree of vigilance must be exercised and every reasonable precaution taken to guard against accident or explosion. While its measure of responsibility is not that of an insurer, the company is liable for an explosion when it knew, *or by the exercise of ordinary care should have known*, of a defect in its pipes or mains. See *Heh v. Consolidated Gas Company, 201 Pa. 443; Hartman v. Citizens' Natural Gas Company, 59 A. 315, 316; Shirey v. Consumers' Gas Company, 64 A. 541; and Stephany v. Equitable Gas Company, 31 A. (2d) 523.*

Generally speaking, a gas company is under no duty to inspect or repair service pipes leading from the street to the consumer's property. Usually service pipes belong to the property owner and under his control. Consequently, there is no duty on the part of the gas company to inspect, maintain or repair them, that obligation resting exclusively upon the owner or tenant of the property. For verification, see *Greed v. Manufacturers' Light & Heat Company, 238 Pa. 248; Windish v. People's Natural Gas Company, 93 A. 1003, 1004; Pouder v. People's Natural Gas Company, 245, 93 A. 1005; and Hanley v. People's Natural Gas Company, 188 A. 157.*

However, this principle of nonliability on the part of the gas company in the case of a service pipe, as distinguished from its own mains, is not without exception. If the gas company knows that there are defects in such a pipe, or is in possession of facts which should reasonably inform it that it is unsafe, it then becomes its duty to investigate the safety of the pipe before it continues to use it for the transportation of gas, and if it fails in that duty it becomes liable for any resulting accident. More specifically, if the company knows, or under the circumstances has reason to know, that a service line is rusted and corroded to such an extent as to permit gas to escape therefrom, it is its duty either to notify the customer to repair it, or to shut the gas off at the street in order to avoid the likely danger. See *Pouder v. People's Natural Gas Company, 93 A. 1005, 1006; Heller v. Equitable Gas Company, 3 A. (2d) 343, 344; and Stephany v. Equitable Gas Company, 31 A. (2d) 523.*

Also, see *Goodman & Thoise, Inc., v. Scranton Spring-Brook Water Service Company, 43 Atl. (2d) 111*, where it was shown that in 1916 a service pipe for gas was installed in a residential property. In 1928 the gas company was notified that gas was no longer required for this property. Accordingly, it removed the meters from the house and stopped the service, but, instead of disconnecting the line at the curb, it merely capped the service pipe inside the cellar wall and retained gas in the pipe under pressure from the street main.

In 1929 a factory building containing a power plant was erected upon the lot; the basement was located in a different place



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than the old cellar and a concrete floor was laid upon the filled-in ground over this pipe. On May 24, 1943, the factory building and plant were severely damaged by a violent gas explosion and a number of additional minor explosions which occurred intermittently thereafter during the succeeding two hours.

The lower court held the gas company liable for $20,000. The higher court generally approved the verdict except that it believed the damage allowance was too low. The court said:

"While the pipe itself continued, of course, to belong to the owner of the property, the gas in it belonged to defendant."

Leaking Water Mains

It is important to know that the higher courts consistently hold that neither a municipality, water company or gas company is an insurer of the good condition of its water or gas pipe lines. Therefore, where the defective condition is not a result of negligent construction but the result of wear and tear, the testimony must prove that the condition which produced the damage had (1) been brought to the prior notice of the city or corporation officials, or (2) that the condition had existed for such a space of time that the defect could have been discovered and repaired, had the corporation employees exercised the same degree of care that would have been used by other reasonably prudent and experienced employees under the identical circumstances. Otherwise the city is not liable.

For example, in *Stein v. City of Newark, 52 Atl. (2d) 66,* the testimony showed facts, as follows: A property owner named Stein observed that his building had several cracked walls. He inspected the basement and found that the floor had sunk and that the foundations were no longer holding up the building. A few days later Stein brought this condition to the attention of the Water Department of the City. This was the first time this condition was brought to the attention of the Water Department. It was discovered that a water main had broken, and was leaking water, and that this leak had caused the damage to the buildings. The very next day the city officials, after making an investigation and examination of the premises, immediately and promptly repaired the damaged pipe and shut off the water. Stein sued the city for damages.

After carefully considering all testimony the higher court refused to hold the city liable, and said:

"...Certainly, the city acted with reasonable promptness in shutting off the water and repairing the leak, after being notified by the plaintiff of the condition of affairs as the plaintiff understood and found them to be."

Law of Fixtures

Few readers realize the importance of being able to distinguish between ordinary chattels and legal fixtures. Occasionally, one who sells steam power plant or comparable equipment under a conditional contract of sale, or chattel mortgage, is deprived of repossessing such equipment

although the owner of the building in which it is installed breaches his contract and fails to make agreed payments.

The same unfortunate situation exists where the owner of such equipment installs it in a leased building which subsequently is sold or mortgaged. It is certain that a new purchaser of the building, or holder of a mortgage on the building, may prevent a tenant from removing from such building all legal fixtures. Hence, sellers and buyers of power equipment both are in the same classification and may be prevented from repossessing legal fixtures.

For example, in *Arco Company v. Hawthorne Company, 38 Atl. (2d) 290*, it was shown that a building was specifically constructed for ice manufacturing purposes. A considerable quantity of ice manufacturing equipment including pumps, engines, condensers, and the like, were sold and installed in the building under chattel mortgages and conditional contracts of sale. The owner of the building and land gave a real estate mortgage thereon after the chattel mortgages were properly recorded.

Later it was contended that the manufacturing equipment was a "part" of the real estate and, therefore, the mortgage on the real estate should include the equipment. The higher court held that the real estate mortgage covered and included the land, building thereon and all the ice-manufacturing equipment.

The importance of this decision is readily apparent, because the seller of power plant equipment may forfeit his lien, although he sells the equipment on a conditional contract of sale, in event the holder of the real estate either mortgages or sells it. And the holder of a mortgage on real estate and also a new purchaser of the real estate automatically takes legal title to all legal fixtures.

Parts Interchangeable

Considerable discussion has arisen from time to time over the legal question: Can a seller who contracts to install a "specific" unit install a different but equally efficient unit, without being liable to the purchaser for breach of the contract?

For illustration, in *Mathis v. Holland Company, 166 Pac. (2d) 518*, the testimony proved that a plant owner, named Mathis, entered into a written conditional sales contract with a company for the installation of a unit. The contract stipulated that No. 250 furnace would be installed. After the job was completed Mathis signed a "completion" certificate certifying "that all articles and materials have been furnished and installed and the work satisfactorily completed. . . ."

Several months later Mathis sued the company for damages on the plea that although he paid for a No. 250 furnace the company installed a No. 2500 furnace against his will and consent. The officials of the company admitted during the trial that a No. 2500 furnace was installed but alleged that the two furnaces, No. 250 and No. 2500, were structurally the same. Parts were interchangeable, except for minor castings, and the price list was the same on both. The higher court refused

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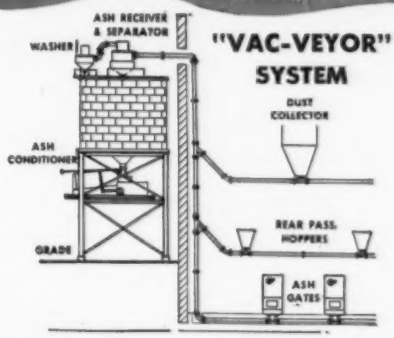

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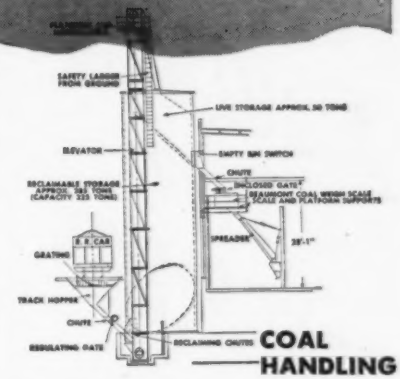

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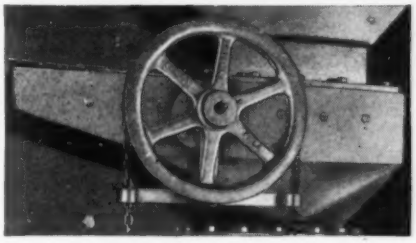

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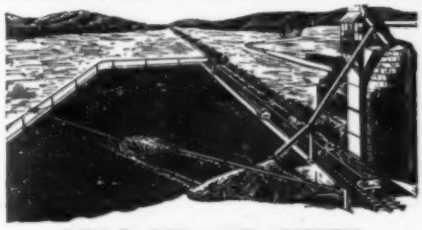

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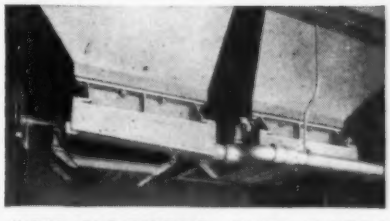

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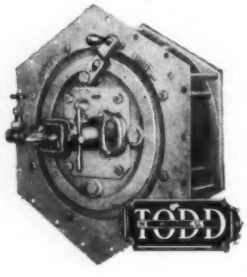

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to hold the furnace company liable, and said:

"The record definitely bears out the fact that the only difference between the two furnaces, No. 250 and the No. 2500 which was installed, is the number on the door and the change in the method of installing the baffle-iron in back of the fire-box; that in all other respects the two models were the same, the same fire-box capacity, the same heating capacity and efficiency, the same material and weight, with the parts interchangeable, and the same value."

Also, see *Holt v. Sims, 102 N. W. 386.* In this case a contractor agreed to install a "No. 3" boiler. The contractor was unable to obtain a No. 3 boiler and a No. 5 boiler was furnished which was a better and greater capacity unit than the one specified in the contract.

In a subsequent suit the higher court held that the plant owner must pay the full contract price.

Corporation Breaches Contract

Few persons realize that when construing a sale contract, the courts frequently base decisions upon the *conduct* of the contracting parties rather than the exact written or verbal *words* in the contract.

For illustration, in *Acme, 39 Atl. (2d) 422,* it was shown that a rock corporation entered into a written contract by the terms of which it agreed to furnish an engineering company which was constructing a power plant with a large quantity of crushed stone. An important clause in the contract was that the rock corporation would furnish 500 to 600 tons of rock each day only to December 1.

The corporation furnished 46,601 tons of rock but did not supply between 500 to 600 tons a day after December 1. Later the officials and sales representatives of the corporation contended that the December 1 provision, above mentioned, in addition to the other "contingencies" in the written contract, relieved it from furnishing over 500 tons of rock every day particularly since weather conditions, and shortage of railway cars, after said December 1, interfered with the corporation making these daily deliveries.

The purchaser sued the corporation for damages.

Notwithstanding the fact that the corporation defended the suit on the grounds that, according to the written contract, it was not obligated to supply 500 to 600 tons of rock a day after December 1, the higher court held the corporation liable for $32,728 damages.

This court explained that although the written contract specified that the corporation need supply 500 to 600 tons of rock a day only to December 1, yet the decision in favor of the purchaser was based upon testimony that the conduct and verbal agreements of the corporation's representatives indicated conclusively that the corporation intended to supply 500 to 600 tons of crushed rock each day until the purchaser's construction contract was completed.

Abandonment Is Intent

Considerable discussion has arisen from time to time over the legal question: When does a power company automatically abandon its right to maintain a dam or other obstruction in a stream when the water rights are reserved in a deed? The answer would appear: Never, unless it *intended* to so abandon the water rights.

For example, in *City of Elkhart v. Christiana Hydraulics, Inc., 59 N. E. (2d) 353,* it was shown that in 1896 a property owner sold certain land to a corporation and executed a deed. The property owner reserved in the deed a right to keep and maintain a dam he had in the stream. At the time the deed was executed the property owner was using power from his dam for the operation of a paper mill. Years later the property owner's dam washed out.

Counsel for the city contended that the property owner had abandoned his legal right to use his dam because it had been in disuse since 1916. The higher court refused to agree with these contentions, saying:

"Appellants (city) contend that the appellee (property owner) in title had abandoned his water rights. No evidence to support this contention has been pointed out except the fact that appellee (property owner) had not used the water for a long period of time."

Easement Different

Although a property owner does not abandon a reparian right without intent an easement may be abandoned by disuse. Thus, if a property owner has forfeited his right to an easement his contract is void by which he sells both the land and easement.

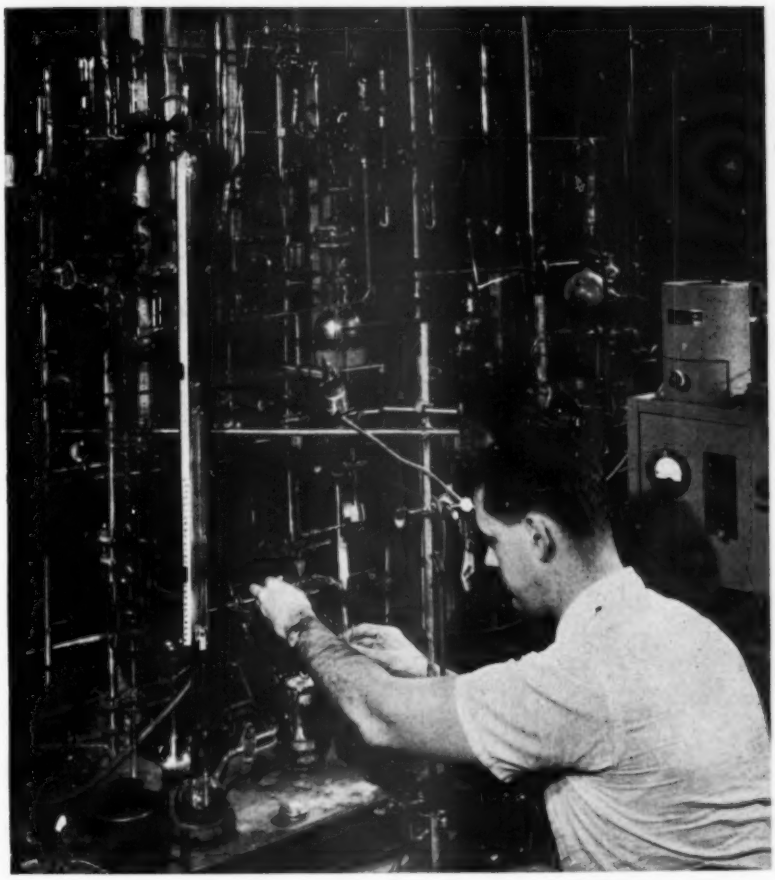
In *City of Harrodsburg v. Cunningham, 184 S. W. (2d) 357,* it was shown that from 1854 to 1926 a man named Williams had maintained a dam which formed a reservoir to provide water to a power plant. The dam was continuously maintained until January 1926, when Williams had it removed. At that time the plant was in a dilapidated condition and had not been operated for many years.

The higher court held that disuse of the dam for eighteen years automatically forfeited the right of Williams to make a valid contract granting the right to another to construct and maintain a dam. The court said:

"In my opinion, at the time Williams made this conveyance he had lost the right to this easement, by reason of having abandoned it, and, consequently, plaintiff (city) did not acquire any such right. It is well settled that an easement may be lost by abandonment."

A Correction

In the article entitled "Burning Bagasse at Cuban Sugar Centrals," in our January 1948 issue, the illustrations of Figs. 8 and 9 were inadvertently interchanged and the error was not detected in time to make the correction before the magazine went to press. However, these furnaces were correctly identified in the reprints that were subsequently made of the article.



Laboratory setup for exploring gasoline source

Isotopes Used in Oil-from-Coal Research

The production of oil and gasoline from coal by the Fisher-Tropsch process involves the making of hydrogen and carbon monoxide, which are then converted into oil or gasoline by passing over a metallic catalyst.

It has been assumed, but never proved, that the product results from the reaction of hydrogen with metal carbides, which have been formed during the process from carbon monoxide and the metal catalyst. If, however, it is created by some reaction not involving metal carbide formation, as now appears possible, the whole viewpoint on the process might be changed.

Therefore, to trace this process scientifically, Gulf Oil Corp. has initiated a research project at Mellon Institute involving radioactive tagged atoms, or isotopes of carbon, called carbon 14. By sampling for the presence of the radioactive atoms in various stages of the process by means of a Geiger counter, the researchers hope to trace the course of carbon atoms and thus blueprint the entire reaction.

100,000-Kw, 3600-Rpm Turbine-Generator

A 100,000-kw, 3600-rpm turbine-generator unit, the first machine of its size designed for 1000 F steam operation, is now in full scale service in the Essex Generating Station of the Public Service Electric and Gas Company, New Jersey.

Built by the General Electric Co., the machine is the largest of its type in the world. It measures 77 ft in length and is 17 ft wide at its broadest point. The turbine, with 19 stages in the high-pressure casing and five stages double-flow in the low-pressure section, was designed for steam conditions of 1250 psi, 1000 F, 1.5 in. mercury absolute back pressure.

It exhausts through 23-in. long last-stage buckets of special warped design. The last-stage buckets, which operate at 1390 ft per sec are mounted on a larger wheel than previously had been used on 3600-rpm machines. The 1390 rate is approximately 10 per cent higher than previous 3600-rpm machines were capable of attaining.

Special provisions are made for the elimination of moisture and the reduction of moisture cutting of buckets. The turbine has a newly developed hydraulic and lubrication oiling system with the centrifugal pump mounted on the turbine shaft fed by an oil-driven booster pump in a separate oil tank in the basement.

The main generator is rated at 95,000 kw, with a power factor of 0.85 and a short-circuit ratio of 0.85 at 15 psi hydrogen pressure.

The set also is equipped with a 7500-kw direct-connected house alternator.

This turbine-generator is the first to be delivered of three similar units ordered by the New Jersey utility.

Central Electricity Board Issues Its Last Report

Great Britain's Central Electricity Board, which was dissolved on April 1 to be replaced by a public-ownership body, the British Electricity Authority, has just issued its twentieth and final report. This contains interesting information concerning the fuel situation, shortage of capacity, new construction projects and average station performance.

The Grid itself comprises 5172 miles of transmission lines fed by 142 selected generating stations having an aggregate installed capacity of 11,881,731 kw, of which 293,425 kw were added during the past year. The total 1947 output was 42,579,000,000 kwhr which was an increase of 3.2 per cent over 1946 and more than a sixfold increase during the 21 yr of the Board's existence. The maximum demand, incurred on January 29, was 9,271,000 kw. The load factor, based on demand actually met in 1947, was 47.2 per cent.

Fuel Situation Discussed

The report deals in detail with the fuel situation and with the load shedding which became necessary during the early months of last year. By the first week in February the coal stocks at many of the generating stations had fallen to less than two weeks' supply and in some cases to less than one week. Coal deliveries had become deranged by the severe winter and it was necessary to shed load on numerous occasions up to 21.2 per cent of the total.

Inferior coals allotted to the power industry resulted in an average reduction in calorific value from 11,522 to 10,893 Btu per lb, a marked increase in the ash content, and a consequent increase in the average station heat rate. For the year 1947 this rate averaged 1.5 lb per kwhr as compared with 1.34 in 1938. Despite the poorer coals, the average cost per ton of coal consumed at all the generating stations operating under direction of the Board increased from 20*s*. 3*d*. in 1938 to 48*s*. 3*d*. in 1947.

New Capacity Cut

To meet a rapidly growing demand for electricity the Board early in the year initiated a construction program involving the addition of 2,315,750 kw capacity to be completed by 1952. This would have brought up to 9,474,450 kw the total new capacity which it was contemplated would be brought into service during the years 1948 to 1952, inclusive. However, at the insistence of the Government, it became necessary to cut this program by 1,635,250 kw for the two years 1951 and 1952. The Board's program for the seven-year period 1946–1952 originally provided for the construction of 31 new generating stations, but as a result of government cuts, five of these will be postponed till after 1952.

The report concludes with reference to arrangements that have been made for the installation of two experimental 15,000-kw gas-turbine sets—one in the Dunston Station of the Northeastern Electric Supply Company and the other in the Trafford Station of the Stretford and District Electricity Board.

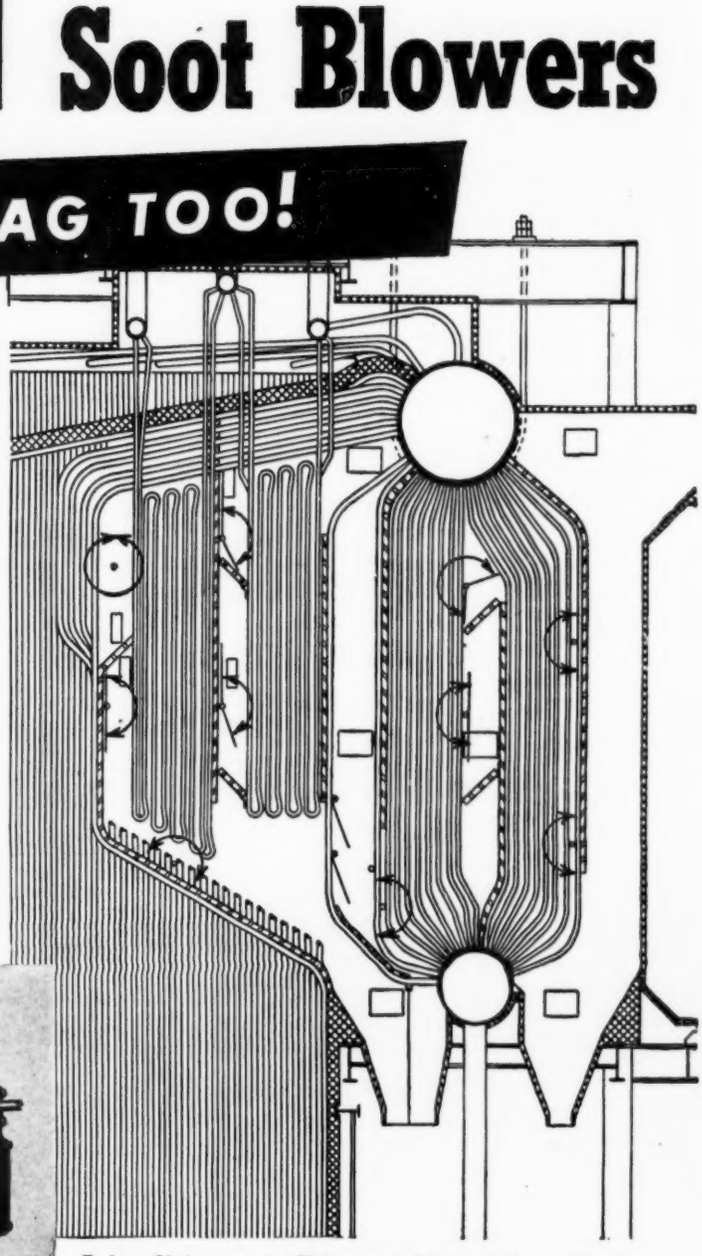
VULCAN Soot Blowers

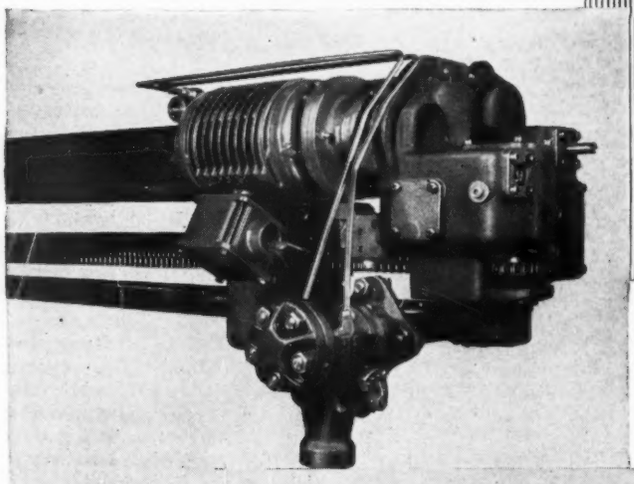
REMOVE SLAG TOO!

Vulcan Soot Blowers have been selected for the 120,000 lb. per hr. Foster Wheeler steam generators in the Staten Island Edison Company and New Bedford Gas & Edison Light Company Plants.

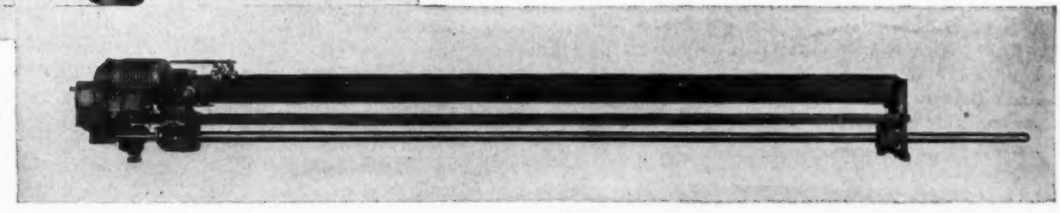
Model T-2 electric torque motor driven long retractable units are used in the high temperature location between the slag screen and superheater to assure adequate cleaning of slag, soot and ash deposits in this important zone. The superheater and boiler tube banks are effectively cleaned by manually operated multi-jet rotary elements Model LG-3.

Steam at 875 psig is used as the cleaning medium.





Below: Vulcan model T-2 retractable soot blower for removing soot and slag in high temperature gas zones. One electric motor extends the soot blowing element into the boiler, and another continuously rotates the soot blowing element while it is being extended and retracted. The steam valve opens automatically as soon as the nozzles clear the side wall and closes automatically when the element is retracted.



Above: Close up of T-2 operating mechanism.

VULCAN SOOT BLOWER CORPORATION

Du Bois, Pennsylvania

Synthesis Gas from Anthracite Silt

According to an announcement of the Anthracite Institute, a new process has been developed for the production of synthesis gas from anthracite silt of which it is estimated there are about 200 million tons above ground in addition to some 5 million tons produced annually by the industry.

The process is based upon German methods used successfully in gasifying brown coal, and a pilot-plant is now being constructed by the Institute at Wilkes-Barre. The silt, air and steam are fed into a refractory-lined cylinder in which combustion takes place and the particles of silt float in the gas, making a boiling or fluidized bed. As the heavier ash settles to the bottom and sides of the cylinder, it is removed by a rotary grate. The carbon in the silt reacts with the oxygen to give a producer gas containing carbon dioxide, carbon monoxide, hydrogen and nitrogen. This gas is then passed through a second bed of silt where the carbon dioxide reacts with the carbon to give additional carbon monoxide. If gas of a higher heat value is desired, steam is introduced at the top of the fluidized bed.

Two practical uses for this process are indicated. One is the production of a gas which can be used as colliery fuel, thus releasing the more valuable larger sizes of anthracite for sale; and the other is a gas that may be utilized to produce synthetic oil and petroleum by-products.

Personals

R. A. Wasson, vice president and general manager of Clarage Fan Co., was elected president of the National Association of Fan Manufacturers at its recent annual meeting in Buffalo.

James Wilson has retired as manager of the field engineering section of the Allis-Chalmers steam turbine department after 43 years of service.

Myron F. Freeman, until recently superintendent of power for the Boston Elevated Railway Co., joined Combustion Engineering Co. on April 1 as assistant chief engineer. He had previously been identified with Jackson & Moreland, consulting engineers of Boston, and with Stone & Webster Engineering Corp.

Carl E. Miller, for several years past associated with the War Department Office of Chief of Engineers as fuel adviser, has lately joined the research advisory staff of Battelle Memorial Institute, Columbus, O. Prior to his government work, Mr. Miller was associated for eight years with the Potamac Electric Power Co. of Washington, D. C., and for three years with the Northern Indiana Public Service Co.

Robert H. Knowlton has been elected president of the Connecticut Light & Power Co. He succeeds **C. L. Campbell** who becomes chairman of the board. Mr. Knowlton has been connected with the Company in various capacities since 1917, for the last nine years as executive vice president.

Obituaries

Charles I. Burkholder, vice president and chief engineer of the Duke Power Co., died at Charlotte, N. C., on March 13, following an illness of several months.

A native of Illinois, Mr. Burkholder received his technical education at the University of Wisconsin and then spent some time in the employ of the General Electric Co. at Schenectady, leaving in 1906 to become associated with the late W. S. Lee, chief engineer of the Southern Power Co., predecessor of Duke Power Co. He became chief engineer of the latter company in 1935 and was elected vice president in 1947.

George L. Knight, former vice president of the Brooklyn Edison Co., died at his home in Brooklyn, N. Y., on March 27, at the age of 70.

A graduate of Drexel Institute, he began his engineering career with the Philadelphia Electric Co. and later joined the Brooklyn Edison Co. where he served successively as draftsman, chief draftsman, designing engineer, mechanical engineer and vice president, retiring from the last mentioned position in 1942. He was a fellow of the A.S.M.E., a member of the A.I.E.E.

A. E. M. Shafer, research engineer of the Pennsylvania Power & Light Co. died suddenly at his home in Allentown on April 5 at the age of 50. A graduate of Lehigh University with the class of 1920, he had been associated with the Company for 27 years.

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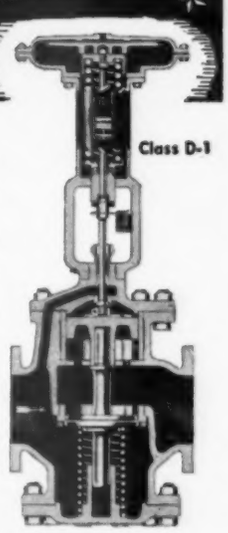

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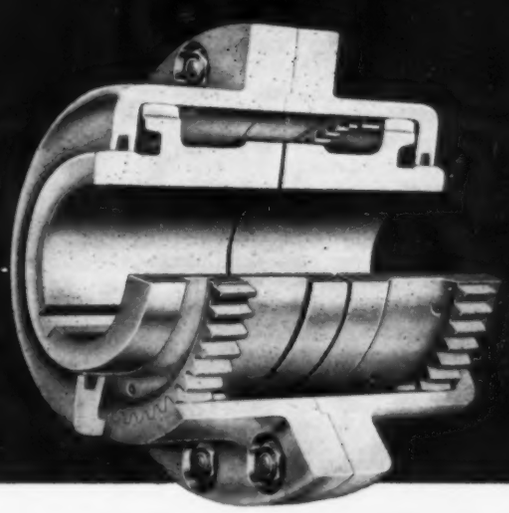

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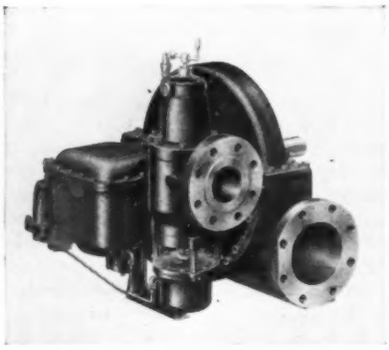
New Equipment

Mechanical-Drive Turbines

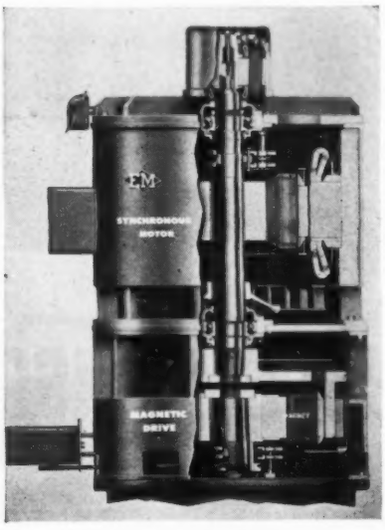
A line of small mechanical-drive turbines, Type DP, with ratings ranging from 10 to 1200 hp and with speeds from 1000 to 5000 rpm, has been brought out by the General Electric Co. These units are available in three single-stage frame sizes with a 16-in., 20-in. and 25-in. wheel, and



embodying such features of large machines as hydraulic governing for wider speed range and more accurate control, and pressure oiling of bearings. The turbines are intended for such applications as driving pumps, compressors, fans, blowers, etc.

Drive Unit for Centrifugal Pumps

A newly available vertical synchronous motor-magnetic drive unit designed to give smooth adjustable speed control for centrifugal pumps has been announced by Electric Machinery Mfg. Co., Minneapolis. The motor drives the ring of the magnetic drive at constant speed and the magnet member of the magnetic drive mounted on the gear shaft operates the pump at a speed required by liquid level control. The unit is claimed to offer smooth, wide-range speed control, preclude "hunting" and eliminate frequent motor starts and stops. The cutaway illustration shows a 250-hp, 1200-rpm unit of this type which operates 200-rpm vertical sewage pumps through a reduction gear.



Liquid Level Alarm

A new device to set off warning signals when liquid levels reach a predetermined low or high has been brought out by The Reliance Gauge Column Co., Cleveland, O. Known as the "Levalarm," the device

is designed for use with pressures up to 250 psi. Briefly, its operation is by means of an electric switch which functions through the agency of a permanent magnet when a monel float rises or falls in a separate float chamber.

Anthracite Conference

The Sixth Annual Anthracite Conference is scheduled for May 6 and 7 at Lehigh University, Bethlehem, Pa. Sessions are scheduled on (1) mining and preparation; (2) general topics bearing on anthracite; (3) a symposium on anthracite in power plants and (4) uses of anthracite. Among these papers, the following should be of particular interest to power men:

"Anthracite's Part in Smoke Abatement," by **J. F. Barclay,** U. S. Bureau of Mines.

"Future Supplies of Principal Fuels in Competition with Anthracite," by **J. A. Corgan,** U. S. Bureau of Mines.

"Factors Affecting Anthracite Markets," by **J. D. Jillson,** Anthracite Institute.

"The Burning of Anthracite in Power Plants," by **R. L. Hallman,** Pennsylvania Power & Light Co.

"Pulverized Anthracite Installation at Suburban Plant of the Scranton Electric Co.," by **D. D. Schulz,** Scranton Electric Co.

"Upgrading Fine Sizes of Anthracite by Extrusion," by **P. A. Mulcey** and **J. W. Eckerd,** Anthracite Institute Laboratory.

"Present and Future Anthracite Burning Equipment," by **R. C. Johnson,** Anthracite Institute.

Luncheons and banquet have been omitted from this year's program. The first session will open at 1:30 p.m., Daylight Saving Time, on May 6, with an evening session at 8 o'clock. The Friday session will start at 9:30 a.m. and continue throughout the day.

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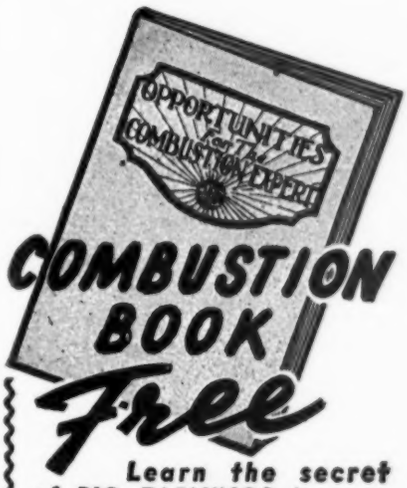

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Business Notes

Due to the unprecedented demand for trained instrument engineers **Bailey Meter Co.** has expanded its staff of field engineers by making the following assignments of men who recently completed its Cadet Engineering Course: H. E. Bitler to its Buffalo Office; M. J. Bonnette and R. W. Hooper to the Houston area; J. W. Cunningham to its Atlanta Office; H. G. Hilston to its Cleveland District Office; J. O. Meals to the St. Louis Office; and L. W. Meier to the Los Angeles Office. J. R. Brennan, J. A. Hays and R. P. Marche are remaining at the main office in Cleveland where they will be attached to the engineering, research and sales departments, respectively.

J. L. Perez Grovas, consulting chemical engineer, has been appointed as representative in Mexico for the sale and service of the water-treatment products of the Power Chemicals Division of **E. F. Drew & Co., Inc.,** New York. Offices are located at Palma 9-407, Mexico, D. F.

Mr. E. J. McMahon, production manager of the **Dearborn Chemical Co.,** was elected a director and vice president at the annual stockholders' meeting. He succeeds John W. Brashears who has been with the company 52 yr, a member of the Board of Directors since 1912, and who was retired as an honorary director.

Leslie Co., Lyndhurst, N. J., manufacturers of pressure and temperature regulators and controllers, announce the appointment of the following agents to handle industrial sales and services: Welby C. Rouse, Greensboro, N. C.; Equipment Sales Corp., Kingsport, Tenn.; Landes, Zachary & Peterson, Denver, Colo.

John W. Anne has been appointed sales manager of the Jeannette plant of **Elliott Co.** He went with the Company in 1925 immediately after graduating as a mechanical engineer from Penn State.

Hall Laboratories, Pittsburgh, is making a three-way transfer of service engineers in the Pittsburgh, Cincinnati and Birmingham districts. Leonard Highley, Jr., returns to the Pittsburgh home offices after nine years' service in Birmingham. G. Howard Smith leaves Cincinnati after four years there to work in the Birmingham district. Robert G. Hobek, who has served in laboratory work until late 1947, joins the Hall service engineering staff in Cincinnati.

The Henry P. Thompson Co., Schmidt Bldg., Cincinnati, has been appointed sales and engineering representative of **Cochrane Corp.,** Philadelphia, for the Chochrane C-B High Pressure Condensate Return System, in addition to water-conditioning equipment and steam specialties already handled, in western Ohio, nearby Indiana and eastern Kentucky. Individuals serving this territory include Herbert H. Haas, John S. Bower and Kenneth C. Matthews.

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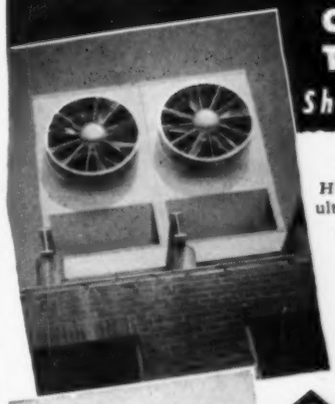

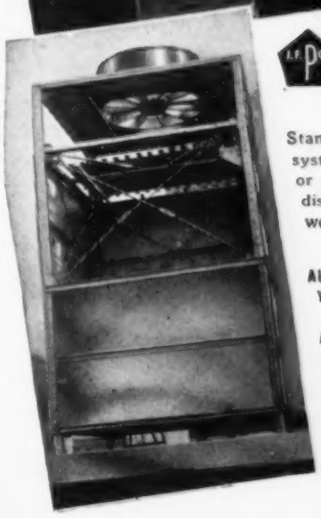

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Fig. 21 Fig. 22

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Fig. 4-F

Fig. 13

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Air Preheater Corporation, The.....Fourth Cover
American Blower Corporation..... 6
Armstrong Cork Company..... 25
Armstrong Machine Works..... 46
Theo Audel & Company, Publishers..... 56
Bailey Meter Company..... 7
Bayer Company, The..... 12
Beaumont Birch Company..... 49
W. H. & L. D. Betz..... 29
Bird-Archer Company, The..... 22
Buell Engineering Company, Inc..... 30
Buffalo Forge Company..... 21
Burrell Technical Supply Company..... 56
Cambridge Instrument Company, Inc..... 55
Carborundum Company, The.....8 and 9
Combustion Engineering Company, Inc.....
.....Second Cover, 16 and 17
De Laval Steam Turbine Company.....23 and 41
Diamond Power Specialty Corporation...Third Cover
Edward Valves, Inc..... 5
Ernst Water Column & Gage Company..... 56
Fairmont Coal Bureau..... 27
Globe Steel Tubes Company..... 42
Grinnell Company, Inc..... 19
Hagan Corporation.....14 and 15
Hall Laboratories.....14 and 15
Hays Institute of Combustion..... 55
Ingersoll-Rand Company..... 20
Johns-Manville..... 18
Leslie Company..... 53
Northern Equipment Company..... 2
Ohio Coal Association..... 11
Pacific Pumps, Inc..... 13
Poole Foundry & Machine Company..... 53
Wm. Powell Company, The..... 10
J. F. Pritchard & Company..... 55
Refractory & Insulation Corporation..... 41
Reliance Gauge Column Company, The..... 24
Sauerman Bros., Inc..... 54
Stock Engineering Company..... 48
Swartwout Company, The..... 26
Terry Steam Turbine Company, The..... 28
Todd Shipyards Corporation, Combustion Equipment Division..... 50
Vulcan Soot Blower Corporation..... 52
Yarnall-Waring Company..... 4